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SYMPOSIUM ON HERNIA

THE INJECTION TREATMENT OF HERNIA

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FACIAL SUTURES IN THE REPAIR OF HERNIA

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SILK SUTURES IN THE REPAIR OF HERNIA

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RECURRENT INGUINAL HERNIA

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INJECTION METHOD OF TREATING HERNIA*

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THE increasing interest in the treatment of reducible hernia by injection is well known to all surgeons. Articles on this subject have appeared frequently in medical journals. Many proprietary solutions are being marketed and their advantages stressed in advertisements in these same journals. Patients are presenting themselves in increasing numbers with the request that their herniae be treated by this new and painless method devoid of the hazards of major surgery, the expense of hospitalization, and the loss of earning power which an operation entails.

For these reasons, it seemed important to us as members of the staff of the Hospital for Ruptured and Crippled, New York, to know from first-hand information what the advantages and disadvantages of the injection method of treating hernia were, and especially, the end-results of this method.

With this purpose in view, and with no preconceived opinions or prejudices, we undertook to treat a series of cases, beginning in October, 1934. Before commencing this work we familiarized ourselves with the technic of injecting herniae and were actually instructed in the method by a doctor who claimed to have had wide experience with it. It is not our purpose to discuss at length the actual technic. Suffice it to say, it requires the application of a well-fitting truss that maintains complete reduction of the hernia at all times. This truss must be worn night and day, for six or eight weeks, and never removed for any purpose whatsoever. Thereafter it is generally considered permissible to remove the truss at night, but during waking hours it must be worn for from 6 to 12 months. Bratrud[12] advises his patients to resume it during a spell of coughing or sneezing. Hay fever patients are advised to wear it during hay fever season; also patients doing any heavy lifting are instructed to put their trusses on during such time.

Our personal experience is based upon a study of 66 patients with 92 herniae, injected in the Outpatient Department of the Hospital for Ruptured and Crippled, New York. Of these, 64 were males, and two were females. Their ages varied from 23 to 84, the average being 50.

Solutions Employed.—At the outset we used a solution known as Piña Mestre, made according to the formula of a Spanish physician, Enrique Piña Mestre. Later we tried out several other solutions, notably, Galtanol, Proliferol, Thuja, and O'Malley's solution. These were used as indicated in Table II.

Number of Injections.—The average number was 21. The highest number given was 36 on each side, and the lowest was four.

* Read before the New York Surgical Society, March 24, 1937. Submitted for publication March 19, 1937.

TABLE I

TYPES OF CASES TREATED

		Herniae
Oblique inguinal		48
Direct inguinal		37
Ventral		4
Umbilical		1
Femoral		2
Total		92
Primary		61
Recurrent:		
Once	24	
Twice	4	
Thrice	3	31
Total		92

TABLE II

SOLUTIONS EMPLOYED AND THEIR RELATIVE FREQUENCE

Solution*	Herniae
P. M.	42
G.	6
O. M.	2
T.	2
P. M. & G.	6
P. M. & O'M.	4
P. M., O'M. & G.	14
P.	1
P. M., O'M., T. & P.	1
P. M., G., T. & P.	2
P. M., P. & T.	2
P. M. & T.	1
P. M. & P.	1
P. M., G., O'M. & T.	1
P. M., G., O'M., T. & P.	1
P. M., O'M. & P.	1
G. & T.	2
P. & T.	2
P. M., G., T., P. & Sodium Morrhuate	1
	92

* *Explanation of Abbreviations:* Piña Mestre—P. M.; Galtanol—G.; O'Malley—O'M.; Proliferol—P.; Thuja—T.

Duration of Treatment.—The average length of time between the first and last injection was 140 days, or from four to five months.

TABLE III

RÉSUMÉ OF SYMPTOMS FOLLOWING INJECTION

Symptoms	Cases
None	45
Pain, slight in 4, severe in 1	5
Chill following injection	1
Nausea, headache, anorexia	1
Dysuria	1
Swelling in scrotum or groin	4
Impotence or sexual impairment	3
Not stated	8

TABLE IV

RÉSUMÉ OF COMPLICATIONS FOLLOWING INJECTION

Complications	Cases
None	52
Swelling of testis	2
Slight atrophy of testis	1
Infection	1
Hydrocele	1
Herpes labialis	1
Edema of leg	1
Not stated	7

As will be seen, our series shows few complications, and these for the most part were not serious. Thus we believe that with care the injection treatment may be carried out with little risk of disaster. There are a number of references, however, in recent literature describing impotence, hydrocele and atrophy of the testis. Zieman and Larkowski[1] recently reported necrosis of cord structures following the injection treatment of reducible hernia. Peritonitis has been mentioned as resulting from injection of the solution too deeply. Yet this rare complication should ordinarily be avoidable.

In our experience, impaired sexual power was the most troublesome sequela, although its cause is difficult to explain except on psychic grounds; especially as the worst complaint came from a patient in whom only one side had been injected.

Mortality.—Fowler[2] quotes Wolfe[8] as reporting that in experimental work with rats, injections were accidentally made into the peritoneal cavity; the resultant inflammation caused a fatality, while autopsy revealed many firm adhesions; but his injection doses, considering relative body weight, exceeded by 20 to 30 times those ordinarily employed in the treatment of human beings. Fowler further states that only two fatal cases have been reported in some 30,000 cases injected.

There were four deaths in our series but none as a direct result of the injection treatment. Death was due in one case to suicide, in another to complications following an accident entirely unrelated to the hernia or the injection treatment. In the third case the relation of the previous injections to the fatal outcome is less clear. The patient was an adult male, age 54,

who received five injections in our clinic. He then disappeared and turned up later at another hospital where an operation was performed; apparently the operation was fraught with unusual difficulties because the femoral vein was injured, necessitating a later amputation of the thigh. The patient finally succumbed as the result of a pulmonary embolus. In the fourth case, the death was reported by a neighbor.

Experimental work on animals has been reported by several observers who have at the same time presented photomicrographs demonstrating the tissue reaction and fibroblastic response to the various solutions injected. There is little doubt in our minds that in the human being a similar tissue reaction takes place. However, we have not seen sections taken from animals at a late date after the injection, with the exception of some photomicrographs kindly sent us by Dr. Frank A. Kelly, of Detroit, who is keenly interested in this subject. We quote from a personal communication from him as follows: "I am sure that if we could maintain the original condition which we produce, and which you have found clinically and we have found in our dogs, that we could cure a large percentage of herniae. However, no solution has yet been devised that will maintain this tissue. I am not as yet, however, convinced that such a solution may not be devised." In several of our cases treated by injection, subsequent operation was performed because of failure of the injection method. We were interested in the findings at the operating table and also of the tissue which we removed for histologic examination. The interval between the last injection and the operation varied, but in all cases a sufficient length of time had elapsed to permit the early proliferative changes to subside. In no case did we find the clinical or microscopic evidence of a strong bulwark of built-up scar tissue, which is claimed by many workers to result from the injection treatment. In one or two cases some strands of connective tissue partially occluded the opening of the neck of the sac. There was some increase in the fixation of the external oblique aponeurosis to the underlying muscle and conjoined tendon, but in the main there was little residual evidence of efficient conversion of weak areas of the abdominal wall into strong resistant layers. In fact, for the most part, there was little evidence of any residual tissue reaction of consequence.

Operative and Pathologic Findings in Eight Cases Previously Injected*

Case 1.—W. J. C. (No. 13, Table VI): Operation October 31, 1935 (B.L.C.). The operative findings, unfortunately, were not fully recorded. It should be noted that this patient had had three operations prior to the injection treatment, and that the present operation was the forth. All anatomic landmarks were much obscured or obliterated. The remnant of the cord was removed. The sac was opened and found to contain a segment of sliding sigmoid. The transversalis fascia and muscles were sutured to Poupart's ligament. The Wangensteen pedicled flap taken from the fascia of the thigh was sutured to Poupart's ligament. Silk technic was used throughout.

Pathologic Examination.—Gross: Dr. D. A. DeSanto. Specimen consists of a small string-like piece of dense connective tissue 1 cm. long and a hard pea-sized nodule. *Microscopic.*—Section shows fibro-fatty tissue of hernia sac, infiltrated with numerous

* Since this paper was read Cases 9 and 12, Table VI have also been operated upon.

round cells. One small area shows a simple necrosis. No evidence of newly formed connective tissue. Diagnosis: Hernia sac showing chronic inflammation and focal necrosis.

Case 2.—A. F. (No. 17, Table VI): Operation at St. Luke's Hospital in November, 1936. The sac was found unaffected by the injection treatment; there was no evidence of any result of the latter except in the subcutaneous tissue.

Case 3.—K. G. (No. 20, Table VI): Operation May 19, 1936, by Dr. C. H. Ghent at St. John's Hospital, St. Paul, Minn., who reported as follows: "I excised the old scar and found the external oblique and internal oblique widely separated (about one inch), and very densely and tightly adherent to each other. They lay in a position about as you would expect surrounding several drains, and the only apparent effect of the injections was to increase the scar tissue in this area. The peritoneum and posterior fascia were closed in one layer, the internal oblique overlapped several times and the external oblique overlapped."

Case 4.—R. L. (No. 29, Table VI): Operation July 31, 1936 (C.G.B.). Under spinal anesthesia, the usual inguinal incision was made. Dense scarring of the subcutaneous tissue was encountered. The internal oblique adhered to Poupart's ligament as if it had been sutured. An indirect sac about 4 cm. in length was dissected free from the surrounding tissues. There were no adhesions within the sac which contained omentum, which was readily reduced. High ligation of the sac; Bassini repair with silk technic throughout.

Pathologic Examination.—Gross: Dr. D. A. DeSanto. No. 1: External oblique aponeurosis. No. 2: Internal oblique. *Microscopic.*—No. 1 (a small strip of white tissue about 0.5 cm. long)—Sections show aponeurotic tissue. No evidence of recent or late repair. Diagnosis: Normal aponeurosis. *Microscopic.*—No. 2 (a pea-sized piece of muscle)—Sections show a small mass of scar tissue, several sclerotic blood vessels and foci of round cell infiltration. The appearance suggests an attempt at fibrous repair. Diagnosis: Chronic inflammation.

Case 5.—F. W. L. (No. 31, Table VI): Operation March 20, 1936, at the Englewood Hospital, N. J., for a left oblique inguinal hernia. The surgeon reports as follows: "At operation, the internal inguinal ring on the right side was markedly fibrotic. Aside from that there was no evidence of any reaction to the injection treatment. The treatment had apparently had no effect whatever on the character of the hernia."

Case 6.—B. McG. (No. 34, Table VI): Operation October 29, 1935 (C.G.B.). On exposing the aponeurosis of the external oblique in the vicinity of the external ring, there was a certain amount of fibrous tissue, presumably the result of injection. On incising the external oblique, there were some thin adhesions uniting the external oblique to the cremasteric muscle, also some thin adhesions uniting the external upper leaf to the external oblique muscle. The external ring was fairly well filled with beginning scar tissue. Section 1 was taken from the tissue between the pillars of the external ring.

Throughout the operation there was more bleeding than is usually found in an uncomplicated hernia. There were no adhesions between the muscle and Poupart's ligament. The cremasteric was decidedly thickened. The sac was stripped from its bed as if there was a certain amount of inflammatory reaction, and it was very adherent to the surrounding cord structures. On opening the sac there were found some very thin adhesions which caused almost complete obliteration. There were adhesions between the cremasteric and the internal oblique muscle. There was a definite weak spot just at the edge of the rectus muscle but due to numerous adhesions it was impossible to close it as well as could have been done had the patient not been injected.

It is to be noted that this patient had received 15 injections of the Piña Mestre solution, the last having been introduced on February 18, 1935, so that a period of eight months had elapsed following the last treatment. This must be taken into consideration in connection with the pathologic changes now evident.

Pathologic Examination.—Gross: Dr. D. A. DeSanto. 1. Tissue from external ring: A small irregular piece of firm tissue weighing about 5 Gm. 2. Tissue from hernia

sac: A small flat piece of hernial sac. 3. A small piece of cremaster muscle. 4. Internal oblique above conjoined tendon: A minute piece of tissue. 5. External oblique aponeurosis: A small stringy piece of tissue. *Microscopic.*—1. Sections show aponeurotic tissue, very like scar tissue. 2. Sections show an overproduction of dense collagenous tissue and in some areas new capillary formation. 3. Sections show delicate new vascular connective tissue. 4. Sections show a small cluster of striated muscle. There is a delicate growth of connective tissue separating the muscle bundles and uniting it to an underlying fiber fatty tissue. 5. Sections show aponeurotic tissue. The surface is covered with scar tissue containing a few new blood vessels. There is an actual transformation of the aponeurotic tissue into the area of scar tissue. Diagnosis: Chronic inflammation.

Case 7.—E. M. (No. 42, Table VI): Operation at Bellevue Hospital, April 4, 1935 (C.G.B.). *Clinical Diagnosis*: Strangulated inguinal hernia. *Operative Findings*: Through the usual incision the external oblique was exposed. It was found to have a cadaveric appearance, and to be quite adherent to the internal oblique. On incision, a dark red, distended sac was exposed. This was excised and found to contain about one ounce of dark bloody fluid. The gut was very dark and the blood supply was interfered with for a distance of some three inches. On relieving the constriction and applying hot towels over the intestine, the gut proved to be viable. The sac, which was about 4 cm. in length, was separated. There were no adhesions within it but it was intimately adherent to the cord. The internal ring was very much infiltrated and had to be incised laterally before the intestine could be reduced. The opening therein admitted two fingers; apparently there were firm adhesions throughout the rest of the posterior wall. The cord was excised, the internal oblique and transversalis sutured to Poupart's ligament, and the external oblique closed in the usual manner. Apparently this strangulation occurred because of the nonresiliency of the internal ring due to the infiltration from the injections.

Pathologic Findings.—Four specimens: Specimen 1.—Internal oblique muscle. *Microscopic Examination.*—Section shows a highly vascular congested edematous fibro-fatty tissue with small areas of necrosis and a few atrophic skeletal muscle fibers. There are areas of fibroblastic proliferation and lymphocytic infiltration and one small recanalized blood vessel. Diagnosis: Chronic productive inflammation.

Specimen 2.—Section of spermatic cord. *Microscopic Examination.*—Section shows numerous thick-walled blood vessels, nerves and an edematous thick fibro-adipose tissue. There are a few small foci of fibroblastic proliferation. Diagnosis: Edematous fibro-adipose tissue.

Specimen 3.—Hernial sac. *Microscopic Examination.*—Section shows an edematous, highly vascular, congested, fibrous connective tissue with extensive areas of fibroblastic proliferation and lymphocytic infiltration. Some of the surfaces are covered by a single layer of pavement cells. Diagnosis: Chronic productive inflammation.

Specimen 4.—External oblique muscle. *Microscopic Examination.*—Section shows an edematous congested fibrous connective tissue with small segments of tendon and areas of fibroblastic proliferation and lymphocytic infiltration. Diagnosis: Chronic productive inflammation.

Case 8.—G. P. (No. 50, Table VI): Operation July 16, 1935 (B.L.C.). The subcutaneous tissue was edematous. The aponeurosis in places was necrotic, and in others, showed some evidence of fibrosis and adhesions. The muscles were infiltrated with edema and some scar tissue. The transversalis fascia was not recognizable as such. The abdominal rings were of average size. On the right side was a large scrotal sac intimately adherent to the cremaster, which was enormously thickened. There were a few adhesions in the neck of the sac, not closing it, however. Fluid was found in both sacs. A typical Bassini operation (chronic catgut sutures) was performed with high ligation of both sacs.

Indications for Injection Treatment.—Ross[3] recognizes the following indications for injection: (1) Conscientious objectors to surgery. (2) Economic reasons: (a) Time saved from hospitalization, (b) Cost saved of hospital care. (3) Elderly people. (4) Other poor surgical risks. (5) Recurrent herniae.

We believe that the indications for a trial of the injection method for hernia are definitely limited. We would consider the method unsuitable for any but indirect inguinal herniae, thus excluding not only femoral, umbilical and postoperative ventral herniae, but direct inguinal herniae as well. It should be reserved for small, uncomplicated, simple, indirect herniae in patients who refuse operation steadfastly or in whom operation is too great a hazard to be seriously considered because of age or intercurrent disease. These patients should be told that they will probably have to wear a truss indefinitely during the active portion of each day but that the injections may result in slight fibrosis and this may permit the removal of the truss during inactive periods, and, perhaps, retard the inevitable gradual increase in the size and troublesomeness of their herniae. But that this method should be offered to healthy patients who could withstand operation, as an alternative method, seems to us at present not justified by the results thus far obtained.

Patients whose herniae are not retained completely by the truss are unsuitable for injection unless they are put to bed with the foot of the bed elevated. They are then injected daily until the herniae can be held reduced.

Contraindications for Injection Method.—Ross gives the following contraindications for the injection treatment: (1) Adherent nonreducible types. (2) Large ventral and umbilical herniae. (3) Femoral herniae (cannot be held by a truss and are too near the femoral vein).

Other contraindications are herniae associated with undescended testes or any herniae in which reduction cannot be completely maintained by a properly fitting truss.

Estimation of End-Results.—We would emphasize our conviction that reports of cures by the injection method should be judged by the same critical standards as are used to judge results obtained by operation. To regard an injected case as cured until examination by a competent surgeon at least one year after the truss has been completely discarded reveals no evidence of hernia present, seems to us quite unwarranted. Harris and White,[4] in a recent report of 100 cases treated by the injection method, state that the results up to the date of publication were eminently satisfactory from both the patient's and the surgeon's standpoint. They add that they have had no case in which the hernia has not been completely obliterated subjectively and objectively. They quote a number of other authorities as claiming a recurrence rate of from less than 1 to 4 per cent.

An analysis of the series published by Harris and White, however, reveals the fact that in 33 of the 100 cases, the treatment had not yet been completed. Moreover, of the remaining 67 cases, 39 had been observed for a period of less than three months after removal of the truss, 56 for less than

five months, and only 11 cases had been followed for a period of six months or more.

Rice states that the average incidence of cures as compiled from the figures cited in literature by Kretschmar, Mayer,[6] Campos and Subirachs,[7] Jameson, Wolfe,[8] Wyss,[9] Gray,[10] Wollermann,[11] and Bratrud,[12] total 6,550 cases, was 92.6 per cent. He further states that the results of a questionnaire sent to 23 doctors showed 2,216 cases treated and controlled, of which 85 per cent were cured.

Reporting from Bratrud's Clinic at the Minneapolis General Hospital, Rice[5] stated that 804 individuals with 1,025 herniae had been recorded. In 213, treatment had been advised but not administered as the patients had failed to return. In 115, operation was recommended. In 379 patients with 445 herniae, cures by injections were obtained. Eleven had failed to respond to the treatment. The cures were determined by personal follow up observation, no patient being pronounced cured until the check-up examination failed to reveal any impulse for a period of six months from the date of the last injection, and until the patient had been without a truss for at least four months. If only the controlled cases are calculated, Rice states that the percentage of cures is 97.6.

TABLE V

SUMMARY OF END-RESULTS OF HERNIAE TREATED BY THE INJECTION METHOD AT HOSPITAL FOR RUPTURED AND CRIPPLED, AS OF MARCH 1, 1937

Sixty-six patients injected; four died; six others cannot be traced.*
Of the 56 traced cases:

Known failures.....47, or 81.03 per cent.
(Ten of these were later operated upon)
Possible cures.....11, or 18.96 per cent.
2 well from 6–16 months
9 " " 13–23 "
But 9 of the 11 possible cures are still wearing trusses and will not remove them, leaving
Probable cures.....2, or 3.44 per cent.

* Percentage based on 56 instead of 60 as two were double herniae.

Fowler admits the present state of uncertainty as to the actual end-results of the injection method. He says: "The frank and truthful answer is that as yet we have but little exact and dependable information as to the recurrence rate after the injection treatment. Being ambulatory, that treatment is usually given by private practitioners who have few facilities for following up cases. Hospital and insurance carriers could make the needed study to much better advantage. For myself, I cannot even pretend to have kept track of enough of my cases for a sufficient length of time to warrant my even estimating the recurrence rate."

This, from one of the most experienced protagonists of injection treatment, is important; for it emphasizes the truth that convincing follow-up records have not as yet substantiated claims for the success of the method.

TABLE VI

TABULATION OF HERNIAE TREATED BY INJECTION METHOD AT HOSPITAL FOR RUPTURED AND CRIPPLED

No.	Name	Sex	Age	Type	Primary or Recurrent	Wearing Truss	Result
1.	S. A.	M.	32	LOIH	P.	No	Failure
2.	J. A.	M.	44	RDIH	R—twice	Yes	Failure
3.	J. B.	M.	40	ROIH	P.		Failure
				LDIH	P.		Failure
4.	J. B.	M.	35	LOIH	P.	Yes	Failure
5.	C. B.	M.	63	RDIH	P.	Yes	Failure
				ROIH			Failure
6.	A. B.	M.	47	LDIH	R.	Yes	Failure
7.	H. B.	M.	72	RDIH	P.	Yes	Failure
				LDIH	P.		Failure
8.	J. B.	M.	75	ROIH	P.		Not traced
9.	H. B.	M.	54	ROIH	R.		Died after operation at another hospital
				LDIH	P.		
10.	A. C.	M.	41	ROIH	P.		Failure
11.	L. C.	M.	62	RDIH	R.		Failure
12.	S. C.	M.	54	ROIH	P.	Yes	Failure
13.	W. C.	M.	54	ROIH	R—thrice		Failure
							Wangensteen operation performed
14.	M. D.	M.	44	RDIH	R.	Yes	Failure
				LDIH	R.		Failure
15.	M. D.	M.	69	LOIH	P.		Death reported; cause unknown
				ROIH	R.		
16.	B. F.	M.	23	RDIH	P	Yes	Failure
				LDIH	P.		Failure
17.	A. F.	M.	31	LOIH	P.		Failure
							Operation at St. Luke's
18.	A. F.	M.	37	LOIH	P.		Not traced
19.	D. G.	M.	48	VH	R.	Yes	Satisfactory result. No impulse 23 mos. later
20.	K. G.	M.	27	VH	P.		Failure
							Operated upon elsewhere
21.	J. H.	M.	29	LDIH	R.	Yes	Failure
				RDIH	R.		Failure
22.	S. H.	M.	50	RDIH	R.	Yes	Failure
				LOIH	P.		Failure
23.	M. K.	M.	58	RDIH	P.	Yes	Failure
24.	N. K.	M.	32	ROIH	R.	Yes	Failure
25.	M. K.	M.	51	RDIH	P.		Not traced
				LDIH	P.		Not traced
26.	L. K.	M.	30	RDIH	P.		Failure
27.	L. K.	M.	67	ROIH	R.		Failure
				LOIH	R.		Failure
28.	H. L.	M.	48	RDIH	R.		Failure.
							Operation advised
29.	R. L.	M.	46	ROIH	P.	Yes	Failure
							Operated upon.
							Recurrence
30.	A. L.	M.	60	RDIH	R.—twice	Yes	Right—failure.
				LDIH	R.		Left—solid 6 mos. later
31.	F. L.	M.	36	LOIH	P.		Failure. Operated upon at Englewood Hospital
32.	J. L.	M.	29	ROIH	P.		Not traced

TABLE VI—CONTINUED

TABULATION OF HERNIAE TREATED BY INJECTION METHOD AT HOSPITAL FOR RUPTURED AND CRIPPLED

No.	Name	Sex	Age	Type	Primary or Recurrent	Wearing Truss	Result
33.	S. L.	M.	34	LDIH	R.—thrice	Yes	Failure
				UH			Claims sexual impairment
34.	B. M.	M.	27	LOIH	P.		Failure
							Operated upon
35.	A. J. M.	M.	26	LOIH	R.		Solid 20 mos. later.
							Claims sexual impairment
36.	W.P.M.	M.	56	RDIH	P.	No	Solid 20 mos. later
37.	J.H.M.	M.	35	LOIH	P.	Yes	Solid 18 mos. later
38.	M. M.	F.	45	VH	R.	Yes	Failure
39.	J.F.M.	M.	82	ROIH	R.	Yes	Solid 14 mos. later
				LOIH	R.		Solid 14 mos. later
40.	N. M.	M.	60	RDIH	R.		Not traced
				LDIH	R.		Not traced
41.	W. M.	M.	64	LOIH	P.		Died of pneumonia following fall (fractured rib)
42.	E. M.	M.	74	ROIH	P.		Failure
							Operation at Bellevue
43.	S. M.	M.	65	ROIH	P.	Yes	Failure
44.	C. M.	M.	38	ROIH	P.	No	Solid 19 mos. later
				LOIH	P.		Solid 19 mos. later
45.	A. N.	M.	79	LOIH	P.	Yes	Failure
46.	J.O'B.	M.	58	RDIH	R.	Yes	Failure
47.	O. O'K.	M.	57	LDIH	R.	Yes	Failure
48.	T. O.	M.	59	RFH	P.		
				LFH	P.		Committed suicide
				LDIH	P.		few months later
				RDIH	P.		
49.	J. P.	M.	49	RDIH	R.	Yes	Solid 1 yr. later
50.	G. P.	M.	52	ROIH	P.		Failure
				LOIH	P.		Operated upon
51.	E. P.	M.	50	LDIH	R.—twice		Failure
52.	S. P.	M.	56	ROIH	P.	Yes	Failure
				LOIH	P.		Failure
53.	H. C. Q.	M.	62	LOIH	P.		Failure
54.	C. R.	M.	58	LDIH	R.		Failure
				ROIH	P.		Failure
55.	H. R.	M.	62	RDIH	R.—thrice.	Yes	Failure
56.	A. S.	M.	48	ROIH	R.—twice	Yes	Failure
57.	J. S.	M.	69	RDIH	P.	Yes	Solid 8 mos. later
				LOIH	P.		Solid 8 mos. later
58.	M. S.	M.	60	ROIH	P.	No	Failure
				LOIH	P.		Failure
59.	H. S.	M.	65	LDIH	P.	Yes	Failure
60.	J. S.	M.	40	LOIH	P.		Failure
61.	A. S.	M.	49	LOIH	P.		Failure
62.	I. S.	M.	48	ROIH	P.		Failure
63.	J. T.	M.	78	ROIH	P.	Yes	Failure
64.	S. W.	M.	63	ROIH	P.	Yes	Right—solid 18 mos. later.
				LOIH	P.		Left—failure
65.	J. W.	M.	49	ROIH	P.		Not traced
				LOIH	P.		Not traced
66.	E. Z.	F.	45	VH	P.	Yes	Solid 15 mos. later

Another statement often made is: "That recurrences after the injection method yield so readily to a few more injections that the ultimate percentage of failures is very low indeed."

Until statistics are forthcoming that point to a much higher curability of hernia by the injection method than we have been able to obtain at the Hospital for Ruptured and Crippled, we have definitely decided to abandon the method entirely.

SUMMARY.—(1) Commencing in October, 1934, a series of 66 cases with 92 herniae of various types were treated by injections at the Hospital for Ruptured and Crippled.

(2) Care was taken to observe the precautions as to suitability for injection, and as to prolonged, continuous truss support during and after the injection period.

(3) Several solutions were tried but we found nothing to lead us to believe that there was any special value in one over the others.

(4) The patients on the whole tolerated the injections well; comparatively few sequelae followed. With proper precautionary measures, therefore, the injection of these solutions seems reasonably safe.

(5) Immediate results were gratifying to us in that the impulses disappeared and, generally, for a time no definite evidence of the existence of a hernia was present. This brief period of encouragement would commence after five or six injections and would last possibly for three or four months, particularly if an injection was given occasionally during this period. However, in 47 of the 56 cases followed, a definite relapse was noted usually by both the patient and the doctor; so that at present only 11 cases are apparently cured, and nine of these are still wearing trusses.

(6) It is our belief, based on conditions found at operation on several cases previously injected, that it is extremely difficult to deliver the solution to the exact spot needed to obliterate the sac, and even when the solution does cause a temporary proliferation that either obliterates or masks the impulse, this tissue reaction gradually absorbs or diminishes until a state is reached approximating that which existed prior to the injection. Some scarring may persist, but that this strengthens the defense against a hernia is questionable except when it causes an obliteration of a narrow sac in an individual whose muscles and fascia are otherwise normal. It is generally accepted that scar tissue will stretch and that it is weaker than normal tissue. It seems to us very unlikely, therefore, that in direct herniae one can "build up" tissue by the injection method which will convert a weak musculature and thinned out aponeurosis into a strong resistant abdominal wall.

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FASCIAL SUTURE OPERATIONS FOR HERNIA*

SUMMARY AND END-RESULTS OF ONE THOUSAND, FOUR HUNDRED EIGHTY-FIVE OPERATIONS

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MORE than a decade ago, stimulated by the favorable reports of Gallie and Le Mesurier,[1] we adopted the use of fascia for the repair of certain types of hernia at the Hospital for Ruptured and Crippled, New York; and our statistics during the period from 1924 to 1935 show that in 1,485 operations for hernia in 1,092 patients, fascia of some kind was used.

While a certain number of these patients have been continuously followed, during the past two years a more concerted effort has been made to trace the entire group, and we are now able to report the end-results in about 70 per cent followed from 1 to 12 years.

In the majority of the operations, autogenous fascial sutures from the patient's thigh were selected; but in a certain number of repairs, homologous fascia from another patient or preserved ox fascia was used.

Regarding the indications for the use of fascia, we concurred with Gallie in recommending the procedure for the following: (1) Direct inguinal hernia. (2) A combination of direct and indirect inguinal hernia. (3) Large scrotal hernia in which the canal has lost its obliquity and the internal ring lies approximately behind the external ring. (4) All forms of recurrent hernia. (5) All ventral hernia including the umbilical and epigastric types.

We gradually limited the use of ox and homologous fascia, and in the latter part of this series we used autogenous fascia almost exclusively.

Formerly a long incision was made in the thigh for the removal of the fascia but later most of our sutures were obtained with a fascial stripper, an instrument devised by Dr. Roderick V. Grace which requires only two small incisions in the thigh.

For a long time we felt that the best method of repairing the more diffi-

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cult types of hernia had been found, but a more thorough study of our results has convinced us that this is not so. In the first place, the recurrence rate is too high. In some instances we were impressed with the fact that the drawing of a large needle threaded with bulky fascia through the transversalis fascia and Poupart's ligament produced a weak spot which was not infrequently a predisposing factor in the development of a recurrence.

Our percentage of infection also was higher than it should have been and we were unable to reduce it appreciably. To some extent this may be laid to failure on our part to employ the same meticulous technic and to exercise the same degree of patience as did Gallie in his operations. This was particularly impressed upon one of us on two occasions while watching him operate: The first time, just as we had begun to use fascia; and the second, only a few weeks ago.

In many patients that were reoperated upon, slight evidence of the fascia formerly used could be found, and we were forced to conclude that many of these sutures were eventually absorbed. This is contrary to the results of experiments reported by Gallie and Le Mesurier.

Analysis of Statistics.—Naturally, in the majority of repairs autogenous fascia was used. Sometimes the homologous fascial strips were transferred directly from one patient to another if, as frequently happened, similar operations were being performed on adjacent tables. If there was some definite contraindication to removal of fascia in one patient then simultaneous operations were deliberately planned. In our earlier operations we preserved all excess fascia in "Scott's Solution" (95 per cent alcohol 55, acetone 10, mercurochrome 2, aqua dest. 33) and we did not hesitate to use it for a fascial repair even in a case not preoperatively diagnosed as suitable for that type of operation (Table I).

Table I

SUMMARY AND END-RESULTS OF 1,485 FASCIAL SUTURE OPERATIONS FOR HERNIA

Total number of patients	1,092
Total number of herniae	1,485
Autogenous fascia	1,153
Homologous fascia	101
Ox fascia	231
First autogenous case	2/1/24
Last autogenous case	9/24/35
First homologous case	12/10/24
First ox fascia case	4/26/27

Koontz[4] reports a series of experiments with dead fascia from beeves, that had been preserved in alcohol. In his opinion, the collagen fibers which make up the bulk of fascial transplants are nearly inert bodies that form a part of the living organism, and preservation in alcohol does not alter them. He believes that the dead cells, that is, the dead protoplasm of the grafts preserved

in alcohol, are removed by the invading cells of the host when the graft is implanted because they are dead extraneous matter, but that the fibers of the graft are left intact because they have the same physical and chemical characteristics as like fibers of the host. Our results with the various forms of fascia are shown in Tables IV, V, VIa and VIb.

The age incidence requires no explanation. Suffice it to say that the majority of operations were performed in the third, fourth, and fifth decades. There were two boys, age 14, with ventral herniae following appendicectomy whose conditions seemed to warrant fascial repair (Table II).

TABLE II

AGE INCIDENCE

Oldest	79 yrs.
Youngest	14 yrs.
Average	43.6 yrs.

DECADES

14–19	7
20–29	109
30–39	279
40–49	348
50–59	270
60–69	72
70–79	7

Operative Deaths.—There were nine deaths from pneumonia; six of these patients were operated upon for double hernia, and it is fair to assume that the longer operating time was a predisposing factor. All but one of the patients were over 50 years of age, four were in the fifth decade, three in the sixth, and one in the seventh. Greater care in the selection of patients for operation might have been exercised, but most of our patients were disabled from their herniae so that the added risk of operation seemed quite justifiable.

The incidence of deaths from pulmonary and cardiac complications is the same as one might encounter in any series.

The death from injury to the bladder followed an operation performed by one of the less experienced surgeons who did not recognize the condition at the time. It was assumed that the sac alone had been ligated and the true situation was not appreciated until the following day.

The two deaths from hemorrhage are also difficult to explain. In one case, an inguinal hernia, the deep epigastric vein was injured by a large needle, which resulted in bleeding into the peritoneal cavity. This was not recognized until the other side was operated upon when, on opening the sac, the hemorrhage was discovered. The first side was reopened and the bleeding controlled, but the patient died of shock. In the second case, a recurrent femoral hernia, the femoral vein was punctured by a large needle. The hemorrhage was controlled by ligating the vein but the patient died of shock. These two deaths emphasize the danger of using a large needle. It would

seem that with more care, these fatalities might have been avoided (Table III).

TABLE III

POSTOPERATIVE MORTALITY INCIDENCE

Nonoperative deaths		71
Operative deaths		25 or 2.3%
Cause		
Pneumonia	9	
Cardiac	2	
Hemorrhage	2	
Pulmonary embolus	2	
Pulmonary infarct	2	
Paralytic ileus	2	
Bladder injury	1	
Uremia	1	
Cellulitis	1	
Suicide	1	
Sudden death	1	
Not stated	1	
	25	

ABBREVIATED CASE REPORTS OF OPERATIVE DEATHS

Case 1.—No. 13333. A. P., male, age 44; admitted January 11, 1927. Operation January 12, 1927; for recurrent right oblique inguinal hernia and left oblique inguinal hernia. Ether anesthesia; duration 1 hr., 15 min. Temperature rose to 104° on the second day with frank signs of lobar pneumonia. Died on the fifth postoperative day. Cause: Pneumonia.

Case 2.—No. 13352. M. A., female, age 50; admitted January 17, 1927, with a history of cholecystectomy 19 years previously, and the appearance of a small umbilical hernia three weeks before admission. History and examination otherwise negative. Operation January 18, 1927. Gas-oxygen-ether sequence; duration 1 hr., 5 min. Postoperative convalescence satisfactory until the eighth day, when patient suddenly turned blue, complained of air hunger and died a half hour later. Cause: Sudden; probably pulmonary embolus.

Case 3.—No. 13406. P. O., male, age 45; admitted February 7, 1927, with a history of a left scrotal hernia of at least four years' duration. Operation the following day. Ethylene-nitrous oxide and oxygen sequence; duration 50 min. The next day patient was cold, clammy and cyanotic with weak and slow pulse; temperature 101°. Died first postoperative day. Cause: Not stated.

Case 4.—No. 13617. S. A., male, age 50; admitted April 25, 1927, with a history of bilateral inguinal swellings of two days' duration. Operation April 26, 1927, for double direct inguinal hernia; ox fascia repair. Anesthetic not stated; duration 1 hr., 5 min. Temperature ranged around 103° following operation, with frank signs of pneumonia, until two days days before death when, on the tenth postoperative day, it rose to 105° and later to 108.2°. Patient was jaundiced during the last week of illness and repeated postoperative uranalyses showed albumin and casts. Cause: Pneumonia.

Case 5.—No. 13654. A. D., male, age 27; admitted May 9, 1927, with a history of bilateral inguinal swellings of five months' duration. A right inguinal hernia had been repaired in childhood. Operation May 10, 1927. Gas-oxygen-ether sequence; duration 55 min. The right side was repaired. When the left sac was opened a large amount of blood gushed forth. The right side was reopened and bleeding point located, apparently in the deep epigastric vein, which was ligated. There being no further evidence

of hemorrhage, autogenous fascial suture repair was effected on both sides. Condition continued critical and patient died 11 hrs. later. Cause: Hemorrhage.

Case 6.—No. 13700. W. M., male, age 60; admitted May 30, 1927, with a history of a right scrotal hernia of two years' duration. Operation (homologous fascial repair), May 31, 1927. Gas-oxygen-ether anesthesia; duration 1 hr., 15 min. Contents of sac reduced with some difficulty. Abdomen distended the following day, and signs of bronchopneumonia appeared. Temperature rose to 105° and patient died on the second postoperative day. Cause: Pneumonia.

Case 7.—No. 13855. S. C., female, age 47; admitted July 11, 1927, with a history of a double hernia for about 40 years. Operation July 12, 1927. Gas-oxygen-ether anesthesia; duration 1 hr., 30 min. Evidently in treating the direct sac on the right side the bladder was opened, as two days thereafter there was extensive extravasation of urine and blood between the transversalis fascia and the peritoneum on the right side. This was incised, drained and packed, but the patient died the following, or third postoperative, day. Cause: Bladder injury.

Case 8.—No. 13981. D. M., male, age 67; admitted August 9, 1927, with an umbilical hernia of 35 years' duration. Operation (homologous fascial repair) August 15, 1927; local anesthesia. Convalescence satisfactory and patient allowed out of bed on the thirteenth postoperative day, but began to complain of dyspnea two days later. Developed uremia on the seventeenth postoperative day. This failed to respond to treatment and patient died on the twenty-first postoperative day. Cause: Uremia.

Case 9.—No. 14333. M. A., male, age 34; admitted December 13, 1927, with a recurrent right oblique inguinal hernia of five months' duration that had been operated upon ten years before at another hospital. Operation (homologous fascial repair) December 14, 1927. Ethylene-nitrous oxide and oxygen anesthesia; duration 1 hr., 10 min. Convalescence uneventful. Patient got up on the fourteenth postoperative day, went to the bathroom and dropped dead suddenly, apparently of pulmonary embolism. Cause: Pulmonary embolus.

Case 10.—No. 141. D. C., male, age 54; admitted March 9, 1928, with a history of recurrent right femoral hernia that had been strangulated for about 48 hrs. Operation was performed under local anesthesia. Patient began to bleed three hours after operation and under gas-oxygen-ether the wound was reopened and the bleeding checked. The next morning condition was fair, but later in the day signs of paralytic ileus developed, progressed despite treatment, and patient died the following morning. Autopsy showed enormously distended small intestine, no peritonitis; the bowel at the site of the strangulation was congested, but without perforation. Cause: Paralytic ileus.

Case 11.—No. 275. W. O., male, age 54; admitted May 7, 1928, with a double direct inguinal hernia of three years' duration. Operation May 8, 1928. Gas-oxygen-ether anesthesia; duration 1 hr. Two days later patient developed signs of left upper lobe pneumonia and died the following, or third postoperative, day. Cause: Pneumonia.

Case 12.—No. 809. M. E., male, age 40; admitted with a large ventral defect following cholecystectomy seven months previously. Operation November 20, 1928. Ethylene-oxygen-ether anesthesia; duration 1 hr., 30 min. Following operation temperature rose steadily to 107° on the second postoperative day with signs of progressive cardiac failure and auricular fibrillation. Cause: Cardiac.

Case 13.—No. 821. J. W., male, age 65; admitted November 14, 1928, with a history of a right inguinal hernia of 25 years' duration that had been operated upon elsewhere three years before admission and that had recurred two and one-half years later. Patient was kept in bed until an area of skin excoriation over the hernia had healed; then operation was performed under spinal anesthesia. A sliding hernia containing cecum and appendix was found, the appendix was removed, and the cord divided to facilitate the repair. Temperature rose to 102° following operation and continued at that level. Signs of bronchopneumonia developed and patient died on the second postoperative day.

Case 14.—No. 937. M. O., female, age 49; admitted February 18, 1929, with a history of four abdominal operations through a lower midline incision and an incisional hernia of one and one-half years' duration. She was kept in bed a week; then operated upon February 25, 1929. Ethylene-oxygen-ether anesthesia; duration one hour. Condition was satisfactory the following day, but became worse on the second postoperative day and patient died on the third postoperative day in cardiac decompensation. Cause: Cardiac.

Case 15.—No. 1713A. E. P. G., male, age 29; admitted January 6, 1930, with a recurrence of one week's duration of a hernia that had been operated upon eight years previously. Operation January 7, 1930. Ethylene-oxygen-ether anesthesia; duration 1 hr., 35 min. Orchitis developed on the second postoperative day and the infection spread upwards over the abdominal wall. Sutures were removed on the fourth day, the scrotum was incised and drained on the fifth day, and the inguinal incision was opened widely, extended upwards and packed on the sixth day. By the seventh day the redness and induration extended into the right axilla and down over the thighs. On the eighth day the temperature rose to 107° and patient died. One ampoule of erysipelas antitoxin was given on the fifth day without improvement. Cause: Cellulitis.

Case 16.—No. 1849. E. W., male, age 73; admitted March 10, 1930, with an irreducible umbilical hernia and a recurrence of a right direct inguinal hernia that had been repaired by a fascial suture operation three years previously. After a week's observation on the ward operation was performed March 18, 1930, under spinal anesthesia, and the umbilical and recurrent right inguinal herniae were repaired. Operating time 40 min. Temperature rose to 102° the following day with signs of diffuse bronchopneumonia, and patient died the next day with temperature of 103°. Cause: Pneumonia.

Case 17.—No. 1887A. J. F., obese female, age 54; admitted March 31, 1930, with a recurrence of an umbilical hernia that had been repaired twice before. Operation April 3, 1930. Ethylene-oxygen anesthesia; duration 40 min. The following day patient complained of sudden pain in the chest with a cough, and her temperature rose to 102.8°. A week later expectoration was profuse and blood-tinged. Bloody expectoration continued and patient died on the eleventh postoperative day with a temperature of 103.2°. Cause: Pulmonary infarct.

Case 18.—No. 1909. J. P., male, age 56; admitted April 14, 1930, with a large reducible right direct inguinal hernia of seven years' duration. Operation April 15, 1930. Nitrous oxide-oxygen-ether anesthesia; duration 55 min. Convalescence was uneventful until the morning of the ninth postoperative day, when patient suddenly became cyanotic, had a "slight convulsion" and died 20 min. later. Cause: Pulmonary embolus.

Case 19.—No. 2673. A. H., male, age 56; admitted March 2, 1931, with a double inguinal hernia of three years' duration and a history of a chronic cough for years. Both sides operated upon March 3, 1931. Ethylene-oxygen-ether anesthesia; duration 1 hr., 15 min. Right lower lobar pneumonia developed on the second postoperative day. Progress was satisfactory until the twentieth day, when patient's condition became suddenly worse. Portable roentgen ray showed massive collapse of the right lung. Condition grew rapidly worse and patient died two days later. Cause: Pneumonia and massive collapse of lung.

Case 20.—No. 4279. F. W., male, age 43; admitted June 5, 1933, with a recurrence of a right inguinal hernia that had been repaired a year ago. Operation (homologous fascial repair), June 6, 1933. Ethylene-oxygen-ether anesthesia; duration 35 min. Four hours later patient complained of sharp pain in left chest and showed signs of pulmonary infarction with temperature around 104°. This continued until the tenth postoperative day, when condition grew rapidly worse and patient died. Cause: Pulmonary infarct.

Case 21.—No. 5355. A. J., obese female, age 48; admitted September 23, 1935, with a large irreducible upper right rectus incisional hernia following cholecystectomy ten years previously. Operation September 24, 1935. Ethylene-oxygen-ether anesthesia; duration 2 hrs., 15 min. Following operation the abdomen was considerably distended due to a paralytic ileus, this condition, however, had begun to improve on the second

postoperative day, when patient got to a ward window and jumped to her death. Cause: Suicide.

Case 22.—No. 370. E. A., male, age 61; admitted April 5, 1928, with a double direct inguinal hernia of six months' duration. Operation April 6, 1928—homologous fascial repair. Ethylene-oxygen-ether anesthesia; duration 1 hr. Paralytic ileus developed following operation. Jejunostomy was performed on the third day, but patient died the following day. Autopsy revealed greatly distended small and large bowel with no evidence of peritonitis. Cause: Paralytic ileus.

Case 23.—No. 1624. J. O'C., male, age 42; admitted March 26, 1929, with a large, twice recurrent, left femoral hernia. Operation March 29, 1929, under spinal anesthesia. During the repair the femoral vein was pierced and required ligation. The wound was packed. Operative procedure 1 hr., 45 min. Patient never completely rallied, despite two blood transfusions, and died on the second postoperative day. Cause: Hemorrhage.

Case 24.—No. 1646. S. H., male, age 56; admitted April 2, 1929, with a bilateral inguinal hernia of 16 years' duration and a history of a chronic cough of several years' duration. Operation under spinal anesthesia April 3, 1929, duration 45 min. Two days later presented signs of right lower lobar pneumonia and died on the fifth postoperative day. Cause: Pneumonia.

Case 25.—No. 4240. W. F., male, age 63; admitted April 6, 1931, with a large scrotal left inguinal hernia containing irreducible sliding sigmoid. Operation under spinal anesthesia April 7, 1931; duration 1 hr. The abdomen was markedly distended for seven days; then became somewhat improved. Signs of lobar pneumonia appeared on the ninth postoperative day and patient died the following day. Cause: Pneumonia.

Incidence of Infection.—Notwithstanding the fact that the percentage of infection is higher in the group repaired with fascial sutures than in that repaired with absorbable sutures, our percentages compare favorably with those of other series. It is interesting to note that the rate is lower for the *autogenous* group than for the *homologous* or *ox fascia.* It is higher in the recurrent cases than in the primary repairs—probably the added trauma to the tissues plus the difficulty in obtaining adequate hemostasis played an important rôle. It is difficult to explain the high rates in the femoral types except on the ground that the series is too small for accurate analysis. A further example of this may be found in the recurrent epigastric and umbilical types in which the infection rate was zero (Table IV).

TABLE IV

INCIDENCE OF INFECTION

Total Number of Infected Wounds	133	8.9%
Infection Rate by Type of Fascia		
Autogenous	92	7.9%
Homologous	13	12.8%
Ox fascia	28	12.1%

Infection Rate by Type of Hernia	No. of Herniae	Infections	Per Cent
Inguinal primary	887	64	7.2%
Inguinal recurrent	421	41	9.7%
Femoral primary	14	2	14.2%
Femoral recurrent	10	2	20.0%
Umbilical-epigastric primary	43	4	9.3%
Umbilical-epigastric recurrent	5	0	0. %
Ventral primary	92	17	18.4%
Ventral recurrent	12	3	25. %

It may be of some significance also to note that of the 133 infected wounds, 46 or 34.5 per cent recurred, while 66 or 49.7 per cent remained well over one year, and 21 or 15.7 per cent were not followed beyond the one year period.

Follow-Up Statistics show that one-half of our traced cases have been followed for five years or longer, while 68 per cent have been followed for at least one year. All cases recorded as *followed* have been subjected to personal examination by one or more of us, and letters or hearsay reports were not accepted as sufficient evidence of cure or recurrence.

TABLE V

FOLLOW UP STATISTICS

Not followed (32 per cent)	
Well under 1 yr	320
No follow up	156
Total	476
Followed (68 per cent)	
Operative deaths 25 patients*	34
Recurred in less than 1 yr	107
Recurred after 1 yr	177
Traced and well over 1 yr	691
Total	1009

* 9 of these patients had double herniae.

Traced and well 1 yr	109
Traced and well 2 yrs	92
Traced and well 3 yrs	69
Traced and well 4 yrs	59
Traced and well 5 yrs	92
Traced and well 6 yrs	49
Traced and well 7 yrs	77
Traced and well 8 yrs	56
Traced and well 9 yrs	30
Traced and well 10 yrs	20
Traced and well 11 yrs	26
Traced and well 12 yrs	12
Total	691

Recurrences.—In 975 followed operations for all types of hernia in which one of the three mentioned kinds of fascia was used, there were 284 or 29.1 per cent recurrences. Of these, 107 developed in less than one year and 177 in more than one year, thus proving to us that a one year follow up is entirely inadequate for the purpose of estimating the final percentage of recurrence in hernia surgery. Many authors are satisfied with a one year, or at the most, a two year follow up, and yet one-third of our recurrences were detected after two years; so that if this arbitrary limit were used as a criterion, according to our statistics, less than two-thirds of our recurrences

would be recorded. How long a period should be allowed to elapse before we may classify a hernia appearing subsequent to operation as a new primary or a recurrence, is a difficult question to decide. We have elected to classify them all as recurrences (Table VIa).

TABLE VIa

PERCENTAGE OF RECURRENCES

Before and after 1 yr.	Number of Recurrences	In 1,485 Cases	In 975 Followed Cases
37% recurred in less than 1 yr.	107	7.2%	10.9%
63% recurred after 1 yr.	177	11.9%	18.2%
Before and after 2 yrs.			
60% recurred in less than 2 yrs.	171	11.5%	17.5%
40% recurred after 2 yrs.	113	7.6%	11.6%
Total recurrences.	284	19.1%	29.1%

Recurred under	1 yr.	107
Recurred after	1 yr.	64
Recurred after	2 yrs.	30
Recurred after	3 yrs.	21
Recurred after	4 yrs.	17
Recurred after	5 yrs.	14
Recurred after	6 yrs.	8
Recurred after	7 yrs.	6
Recurred after	8 yrs.	8
Recurred after	9 yrs.	1
Recurred after	10 yrs.	5
Recurred after	11 yrs.	3
	Total..	284

Table VIb shows that the percentage of recurrence following the use of autogenous fascia was practically the same as that for the homologous group, *i.e.*, 27.7 per cent for the former and 28.3 per cent for the latter, while in those in whom ox fascia was employed the percentage of recurrence was distinctly higher, *i.e.*, 35.5 per cent.

The percentage of recurrence according to the type of hernia, irrespective of the kind of fascia used, indicates a lower rate for the primary indirect type. Even this is higher than one would naturally expect but it should be borne in mind that the majority of these patients presented a large scrotal sac with poor musculature. In a previous paper,[3] we discussed the efficacy of dividing and resecting the inguinal segment of the spermatic cord in order to obtain a more secure closure of the inguinal canal. We found that in the primary indirect herniae alone, our results were 50 per cent better than those obtained by other methods of repair. This procedure was adopted in many of the cases in this series.

We have not figured the percentage of recurrence for all the different types of hernia in which different kinds of fascia was used with the exception of the primary indirect type repaired with autogenous fascia. This showed the lowest percentage of recurrences, *i.e.*, 15.4 per cent.

TABLE VIb

PERCENTAGES OF RECURRENCE ACCORDING TO THE TYPE OF FASCIA USED AND THE TYPE OF HERNIAE ENCOUNTERED

Recurrence-rate by type of fascia		
Autogenous	207/746	27.7%
Homologous	17/60	28.3%
Ox fascia	60/169	35.5%
Total	284/975	29.1%
Recurrence-rate by type of hernia		
Inguinal indirect primary	35/202	17.3%
Inguinal indirect recurrent	29/108	26.8%
Inguinal direct primary	80/310	25.8%
Inguinal direct recurrent	63/154	40.8%
Inguinal indirect and direct primary	22/70	31.4%
Inguinal indirect and direct recurrent	5/13	38.4%
Femoral primary	4/13	30.7%
Femoral recurrent	1/6	16.6%
Umbilical and epigastric primary	11/31	35.4%
Umbilical and epigastric recurrent	1/3	33.3%
Ventral primary	25/55	45.4%
Ventral recurrent	7/9	77.7%
Lumbar primary	1/1	100. %
Total	284/975	29.1%
Inguinal-indirect-primary-autogenous	22/142	15.4%
All inguinals primary	137/582	23.5%
All inguinals recurrent	97/275	35.2%

Two years ago we adopted the silk technic, first in selected cases and later as a routine. The fact that we have not used fascia except in a few unusually large ventral herniae where the pedicled fascial flap (described by Wangensteen[5]) was selected, is sufficient proof that we no longer regard fascia as the method of choice for the more difficult repairs. During the period mentioned, with the exception of the ventral herniae referred to, there has not been a single instance in which we did not believe we could give the patient a better chance of a permanent cure with silk than with fascia.

CONCLUSIONS

One thousand four hundred eighty-five fascial suture operations for the repair of all types of hernia are fully analyzed with particular reference to the percentage of recurrence.

(1) Infections are more common in herniae repaired with fascia than in those in which other forms of suture material are used.

(2) The incidence of infection in our series is lowest in the group repaired with autogenous fascia (7.9 per cent); it is much higher in those repaired with homologous fascia (12.8 per cent) and ox fascia (12.1 per cent).

(3) The number of recurrences is discouraging. It is true that fascia

repair was reserved for only the more difficult types of hernia but we had hoped for more encouraging results.

(4) The introduction of a large needle through the transversalis fascia and Poupart's ligament frequently left a weak spot which predisposed to a recurrence.

(5) The fact that in many of our reoperated cases we were unable to find any evidence of the previously used fascial sutures forces us to conclude that the theory of fascial sutures for hernia repair is based on an erroneous principle.

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SILK SUTURES IN THE REPAIR OF HERNIA *

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THE use of the word *repair* in the term *repair of hernia* is exact, but it carries a double meaning in its application to the part done by the surgeon and that part contributed by the patient, and how the patient's contribution may be affected by the manner and technic of the surgeon. Successful repair of the hernia depends in part on the method employed, but even "the right operation properly done," as Moschkovitz used to express it, depends fundamentally on wound repair. It is this fundamental wound repair, that part of hernia repair contributed by the patient, and how it may be affected by the manner and technic of the surgeon, which is the subject of this paper. The criterion of success in a series of cases will of course be the percentage of failures—this in turn depending upon the character and quality of wound repair.

Forty-five years ago Halsted[1] formulated his principles of surgical technic based on the theoretic requirements for the most nearly perfect wound repair, namely, delicacy in manipulation of tissues and the leaving behind of the minimal amount of the least irritating foreign material. For years he

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followed these principles and reported, in 1913, that he had found them valid even at that date when general aseptic technic was at a high level and the "purveyors of catgut," as he expressed it, were supplying a high grade product. His article is commended to your attention. Most of you are familiar with it, but the rereading of it will almost certainly be enjoyable as well as profitable, and those who have not read it should certainly do so at their first opportunity. It is still the classic exposition of surgical technic, and fundamentally sound in essential principles. Of course, in 1891, that which he was particularly interested in was to overcome the high incidence of infection in clean wounds. It is difficult for us to realize the conditions of that era when suppuration was the rule. Please note, however, that it was under those conditions, even when he did not use gloves for every case, that he instituted his technic with a resultant marked improvement in wound healing. The least possible damage to tissues and the use of the finest silk immediately resulted in cleaner wounds, so he and his followers have consistently adhered to the principles of sharp dissection, the ligation of the smallest possible amount of tissue, complete hemostasis and the avoidance of tension by using fine silk that will not stand great tension. When the term *silk technic* is used in this paper, it does not mean just using any old silk in place of catgut, but means the adherence to those principles so clearly expressed by Halsted, and emphasized recently by Whipple.[2]

Our group at the Presbyterian Hospital were brought up in the catgut school, but in the summer of 1929 were persuaded to adopt silk technic in thyroidectomies and a year later in other groups of cases. Our present technic, with minor variations depending upon individual problems, can be briefly summarized under the following headings: (1) General considerations; (2) local technic, and (3) operative procedure.

General Considerations.—The sterilization of operating room supplies, the masking of all individuals in the operating room and the covering of instruments and supplies not in immediate use will tend to protect the wound from all but the minimum of air-borne organisms.

Local Technic.—The skin preparation must be meticulous and towels must be clamped to the wound edges as promptly as possible to protect the field from contamination from the deeper layers of the skin.

Operative Procedure.—The knife used for the skin incision is immediately discarded as are all artery clamps as soon as the ligation has been effected. Sharp dissection is employed as far as possible. Complete hemostasis is insisted upon but the clamping of bleeding points is accomplished with sharp pointed clamps and the minimal amount of tissue is included in the ligature. The finest silk that can be handled is used for ligatures. In suturing the transversalis fascia, the internal oblique to Poupart's ligament, and the external oblique aponeurosis, fine silk is again used on a small needle. This results in the least possible damage to the tissues incidental to placing the sutures. The sutures, therefore, may be placed closer together and need not be tied as tightly. This produces the greatest possible support without

strangulation of the included tissue. The skin is sutured with interrupted silk on cambric needles, a fresh needle for each stitch, and again the sutures are tied loosely. The ideal is a dry wound, with the minimal amount of tearing and strangulation of tissue, and the minimal amount of the least irritating foreign material left behind. As one becomes accustomed to handling the fine silk and accustomed to the steps in the procedure, there is no need to become lost in the ritual, so that one's operating time can be as short as is consistent with good work.

Meleney[3] had been following the healing of clean wounds in the clinic for four years prior to 1930 and continued the study, so that, in 1935, he could report on nine years' study with considerable data on the use of both catgut and silk in wounds. His studies showed a marked superiority in the healing of the wounds in which silk had been employed as compared with those in which catgut had been used. In 1933, a linen suture material was tried for a year in the thyroid cases under my care, while the other division continued to use silk. This linen was slightly heavier than the silk, and it was pointed out to us that we were running a risk of increased infections. On the other service, in 107 cases, there was not a single infection, while in 129 cases under my supervision there was 5 per cent of infections; a figure comparable to the catgut series. The use of this heavier linen was discontinued, and the following year 271 thyroidectomies were performed with only one infection in a drained case, and since then the incidence has been maintained at a low level. This experience indicated that the size of the suture material is one of the important factors in the technic, confirming our experience of several years earlier.[2]

Meleney showed that the inguinal herniae responded as well as the thyroidectomies and other clean operations. In the three years 1931, 1932 and 1933, 176 inguinal herniae were operated upon using catgut, while 303 were performed using silk, the same operators in general working in both groups. The catgut cases showed 5.1 per cent of infection, the silk cases 2.3 per cent, less than half the incidence shown by their competitors. Any case showing even one small stitch abscess was counted as an infection; most of the infections reported were trivial, but even in the serious group the silk cases had the better record. In 1934, 1935 and 1936, the record shows that, in all operations performed with silk, infections occurred in 2, 2.7 and 2.4 per cent, respectively, while in the operations performed with catgut the yearly incidence was 7, 4 and 4.4 per cent. A rough average indicates that infection occurred nearly three times more frequently in the catgut group than in the silk group. These excerpts from Meleney's reports are examples of the facts which have convinced us of the unquestioned value of silk technic in clean operations. These figures do not represent impressions, but are the result of the most careful and painstaking checking on the healing of every clean wound in the clinic. Our impressions 11 years ago were subject to a rude shock when the results of the survey were first reported to us, but this, however, reacted as a real stimulus to us to attempt to bring our infections in clean wounds as close as possible to an irreducible minimum.

The other criterion in respect to hernia repair is to be found in the follow-up statistics as regards recurrences. Longacre[4] has been reviewing all types of herniae in the clinic from 1930 to 1936, and will shortly publish these statistics. He has kindly consented to let me use his figures on the silk versus the catgut cases. No children under 12 years of age are included in this series, which will differentiate it somewhat from many series in which children have been included. All follow up results are based on personal return visits to the Follow-Up Clinic, and no case is included with less than a 12 months' interval since operation. A longer follow up perhaps would be preferable, but various writers state that over 90 per cent of recurrences will make their appearance by the end of the first year. Longacre's figures are based on a series of 702 cases of inguinal hernia of various types. In 244 of these, chromic catgut was used, silk being the suture material employed in the remaining 458. It would seem that this series is of sufficient size to warrant the drawing of conclusions. Table I shows the number of cases of each type in which catgut or silk was used and the percentage of recurrence.

TABLE I

PERCENTAGE OF INCIDENCE OF RECURRENCE FOLLOWING OPERATIONS IN WHICH CATGUT AND SILK WERE EMPLOYED

	Chromic Catgut		Silk	
	Cases	Precentage of Recurrence	Cases	Precentage of Recurrence
Indirect	173	9.8	278	2.16
Direct	22	13.6	89	4.49
Indirect and direct	15	20.	34	5.8
Sliding	12	25.	15	6.6
Indirect recurrent	14	21.4	26	7.6
Direct recurrent	8	25.	16	6.2
Totals	244	12.7	458	3.5

These statistics indicate, without much question, that silk technic gives better follow up results than catgut, and the figures would be even more striking if the more severe types had been distributed between the two series in the same proportion as the simpler indirect cases. Even at that, the catgut series shows for all types of inguinal hernia repair a recurrence percentage nearly four times as great as that of the silk series. The better wound repair associated with silk technic, occurring year after year in all types of operations as well as in those for hernia, is, almost without question, the factor responsible for this difference between the groups, as Longacre will show that the other possible factors such as the operator, type of operation, type of patient, *etc.*, were equally divided throughout the entire series.

CONCLUSIONS

(1) The operative technic as promulgated by Halsted and others involves the slightest possible contamination of the wound, the minimal amount of trauma to the tissues, and the use of the least irritating suture material.

(2) Meleney's reports on the healing of clean wounds at the Presbyterian Hospital for several years show a definite advantage for silk over catgut.

(3) The follow-up results show fewer recurrences where silk was used in the repair of herniae as compared with catgut.

(4) It seems reasonable to assume that silk technic, rigidly followed, is the method of choice in the operation for repair of hernia.

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RESULTS OF HERNIOTOMY IN PATIENTS OF MORE THAN FIFTY YEARS OF AGE *

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VERY little accurate information is obtainable from any source concerning the results of herniotomy in patients more than 50 years of age. On this account, this analysis is offered of a series of 1,032 patients coming within this age group who were operated upon at the Hospital for Ruptured and Crippled, New York, between the years 1926 and 1935, inclusive. This group is approximately 16 per cent of the total number of patients upon whom herniotomy had been performed during this period.

The data reported were obtained from the operative charts and the follow up examinations conducted at the hospital by members of the Surgical Staff. Follow up reports based on anything but personal examination by the operating surgeon are too inaccurate to be of any great value. We have found that the patient's statements as to the result of his herniotomy are often, unfortunately, quite at variance with his actual condition. It is our experience that at least 50 per cent or more of patients with recurrence following operation for hernia were quite unaware of the fact. This may be explained by the fact that the recurrence is so small as compared to the original hernia that it escapes the patient's attention. Also in many instances the patient was relieved of his symptoms for the most part by the operation, although he still has a small recurrence.

Approximately 65 per cent of this group of 1,032 patients had follow up examinations. The minimum period of observation was one year and

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the maximum period ten years, in this survey. It seems likely that a period of three to five years' follow up would be quite serviceable.

In a group of elderly patients such as we are concerned with, the economic conditions recently have made it difficult for them to maintain their residence and to report for examination. This is the only excuse offered for the failure to have all these patients return for observation after at least three to five years.

TABLE I

SEX INCIDENCE		
SEX	NUMBER of PATIENTS	PERCENTAGE
MALES	954	92.4
FEMALES	78	7.6
TOTAL	1032	100.0

* The males predominated about 13 to 1.

TABLE II

AGE INCIDENCE		
AGE in DECADES	NUMBER of PATIENTS	PERCENTAGE
50-59	750	72.7
60-69	248	24.0
70-79	32	3.1
80-	2	0.2
TOTALS	1032	100.0
AVERAGE AGE 56-7 YEARS		

The average age of all patients was 56.7 years. More than one-fourth of these patients were more than 60 years of age. The operative hazard on patients in this age group is obvious. The age as a factor in instances of recurrence must also be apparent. However, the long duration of their herniae, with the increasing size of the swelling, made it impossible for most of these patients to use trusses or any other conservative nonoperative method with any probability of success or comfort. Irreducibility, too, is an important factor that must be taken into consideration in determining the necessity of operative intervention in many of these patients.

These figures show in this series that in primary inguinal herniae, one in every four patients had recurrence, and in recurrent inguinal herniae, one in every three patients had a recurrence. It may be mentioned here that recurrent inguinal herniae had been operated upon previously from one to three times either in our hospital or elsewhere. In view, therefore, of the high recurrence rate present in this series, an effort was made to determine those factors which may have had an influence either directly or indirectly on these results.

The inquiring surgeon may question the advisability of operating in this age group in view of the above statistics. The answer to operation or non-operation is often given by the patient himself. The risk of the operation and the risk of the recurrence should be accurately presented to him. Since approximately 10 per cent of these patients will be shown to have irreducible or strangulated herniae, the possibility of conservative methods in this large

TABLE III

ANATOMIC CLASSIFICATION		
TYPE OF HERNIA	NUMBER of HERNIAE	PERCENTAGE
PRIMARY INGUINAL	1115	81.3
RECURRENT INGUINAL	125	9.1
FEMORAL	49	3.6
LATERAL VENTRAL (P.C.)	35	2.5
UMBILICAL	33	2.4
EPIGASTRIC	13	1.0
INTERSTITIAL	1	0.1
TOTAL NUMBER of HERNIAE	1371	100.0
TOTAL NUMBER of PATIENTS	1032	

TABLE IV

TYPE and SIDE of HERNIA in 1115 PRIMARY INGUINAL CASES with RECURRENCE RATE				
TYPE and SIDE	NUMBER of HERNIAE	PERCENTAGE	RECURRENCE RATE	
A INDIRECT			A INDIRECT CASES	21.2
RIGHT	394	55.5		
LEFT	316	44.5		
TOTAL	710	100.0		
B DIRECT			B DIRECT CASES	32.0
RIGHT	147	51.4		
LEFT	139	48.6		
TOTAL	286	100.0		
C COMBINED			C COMBINED CASES	33.8
RIGHT	70	58.8		
LEFT	49	41.2		
TOTAL	119	100.0		
TOTAL CASES	1115		AVERAGE RATE	25.8

number must be abandoned. The years of irreducibility make for increasing discomfort and disability. The increasing size of the hernia with no other possible means of relief will cause these patients generally to seek the only opportunity of cure that is offered, namely, that of operation.

In using the term "recurrence" here, we mean any recurrence, no matter how small in size. We found that there is great disparity between the anatomic and the symptomatic result of operation. While one in four of the primary inguinal cases, and one patient in three of the recurrent inguinal cases, respectively, had recurrence following operation, only a fraction of these patients with recurrences suffered from symptoms present prior to

TABLE V

TYPE and SIDE of HERNIA in 125 RECURRENT INGUINAL CASES with RECURRENCE RATE

TYPE and SIDE	NUMBER of HERNIAE	PERCENTAGE	RECURRENCE RATE	
A INDIRECT				
RIGHT	27	49.1	A INDIRECT CASES	30.0
LEFT	28	50.9		
TOTAL	55	100.0		
B DIRECT				
RIGHT	37	58.7	B DIRECT CASES	38.0
LEFT	26	41.3		
TOTAL	63	100.0		
C COMBINED				
RIGHT	6	85.7	C COMBINED CASES	25.0
LEFT	1	14.3		
TOTAL	7	100.0		
TOTAL CASES	125		AVERAGE RATE	34.0

operation. Thus while the anatomic result might be impaired by the presence of a small recurrence, the symptomatic result was often much better. For this reason, therefore, we have found the subjective results of herniotomy in these patients were distinctly better than would seem apparent from considering the statistical data given herewith.

The question is often asked as to whether one incurs a greater risk of recurrence in performing a unilateral operation as compared with a bilateral operation. The numerical possibilities of recurrence are certainly greater in performing bilateral as compared with unilateral herniotomy, but whether other factors such as tissue tension, wound infection, duration of wound exposure, *etc.*, also influence these results, we offer the following data for your conclusions. There were 1,240 inguinal, primary, or recurrent herniae operated upon in this series (Table VI).

In this group bilateral herniae were present and operated upon in about one-half the patients. We use the term "bilateral" to indicate either two

indirect or two direct herniae, or a combination of an indirect hernia on one side and a direct hernia on the other, respectively. Recurrence rates in single and bilateral operations are detailed in Table VII.

TABLE VI

INGUINAL HERNIAE (PRIMARY and RECURRENT)		
SIDE of HERNIAE	NUMBER of HERNIAE	PERCENTAGE
RIGHT SIDE ONLY	375	30.2
LEFT SIDE ONLY	247	20.0
BILATERAL	618	49.8
TOTAL	1240	100.0

Bilateral herniotomy in the indirect cases carries a slightly greater recurrence rate than unilateral herniotomy. Bilateral herniotomy in the direct cases carries a much higher incidence of recurrence than unilateral herniotomy. It may also be noted here that the recurrence rate is greater in direct herniae whether unilateral or bilateral.

TABLE VII

RECURRENCE RATE SINGLE and BILATERAL OPERATIONS (PRIMARY INGUINAL HERNIAE)			
TYPE of HERNIA	CURED HERNIAE	RECURRENCES	PERCENTAGE
INDIRECT			
SINGLE OPERATION	235	43	18.2
BILATERAL OPERATION	166	42	25.2
TOTAL	401	85	21.1
DIRECT (including COMBINED)			
SINGLE OPERATION	78	18	23.0
BILATERAL OPERATION	180	67	37.2
TOTAL	258	85	32.9
GRAND TOTAL	659	170	25.8

Relation of Infection to Recurrence Rate.—Under the heading of wound infection are included all cases showing these postoperative wound complications, no matter how trivial or how severe. Many of the so called infections probably in no way affected the operative results, being of such minor nature as skin stitch abscesses, *etc.*

It is evident from these figures that wound infection decidedly increases the possibility of recurrence. Two out of every five infected cases will have a recurrence. The many factors that enter into wound infection need not be discussed here, except as related to this particular series. Notwithstand-

ing meticulous attention to all of those details that make for primary wound healing, there are certain difficulties in maintaining asepsis that arise from the nature of these herniae, their irreducible contents, their prolonged operative exposure, and the more complicated procedures that may be attempted in their cure. Among these operative procedures that may be necessary in herniae in this older group, we wish to report those of division of the spermatic cord, and orchidectomy, respectively. Division of the spermatic cord has been reported by Burdick and Higinbotham.[1] In this group of patients, the operation of division of the spermatic cord was carried out 125 times. Whereas the average infection of all of our patients was approximately 5 per cent, the infection rate after division of the spermatic cord and in orchidectomy was 10 per cent, respectively.

TABLE VIII

RELATION of RECURRENCE to INFECTION

TYPE of HERNIA	NUMBER of HERNIAE	NUMBER of INFECTIONS	PERCENTAGE of INFECTIONS	PERCENTAGE of RECURRENCE
PRIMARY INGUINAL	1115	46	4.13	36.3
RECURRENT INGUINAL	125	13	10.40	41.6
FEMORAL	49	2	4.08	↑
LATERAL VENTRAL (P.O.)	35	4	11.42	
UMBILICAL	33	1	3.03	
EPIGASTRIC	13	2	15.38	
INTERSTITIAL	1	0	00.00	
TOTAL 1371		68	Av. 4.95	↓

The recurrence rate in the primary, inguinal herniae cases with cord resection is distinctly less than the average recurrence rate after herniotomy performed without cord resection. The disparity in the contrasting recurrence rates noted in Table IX may be due to the fact that these recurrent herniae had been operated upon from one to three times previously with resulting great destruction and weakness of the tissues that were essential to repair.

The indications for division of the spermatic cord in these cases have been as follows, according to the suggestion of Burdick and Higinbotham:

(1) Recurrent herniae, in which previously there had been one or more unsuccessful attempts at repair.

(2) Large scrotal herniae, which are irreducible or which cannot be satisfactorily maintained by a truss.

(3) Large sliding herniae.

The group of sliding herniae, on account of the difficulties presented in their operative management, are summarized in Table X.

We believe the above statistics understate the frequency of sliding herniae. However, we accepted in this classification only such cases which, either from the operative findings or as a result of the operative procedure, gave definite evidence of being true sliding herniae. For this reason we have omitted

TABLE IX

RECURRENCE RATE in DIVISION of the SPERMATIC CORD			
TYPE of HERNIA	NUMBER FOLLOWED	NUMBER of RECURRENCES	PERCENTAGE of RECURRENCE
PRIMARY INGUINAL, INDIRECT	52	5	9.8
" " , DIRECT	23	7	30.0
TOTAL	75	12	Average 16.0
RECURRENT INGUINAL, INDIRECT	5	0	0.0
" " , DIRECT	12	7	58.0
TOTAL	17	7	Average 41.6
TOTAL HERNIAE FOLLOWED	92	19	Average 20.6
" " NOT FOLLOWED	33		

INCIDENCE of INFECTION		
TOTAL HERNIAE with DIVISION of the SPERMATIC CORD or ORCHIDECTOMY	INFECTIONS	PERCENTAGE
125 CASES	13	10.4

all borderline cases even though they were designated as sliding herniae on their discharge cards. A sliding hernia is, in our experience, not a simple hernia. It is often difficult to diagnose preoperatively, although the large size as well as the visceral contents of the hernial protrusion may suggest this

TABLE X

SLIDING HERNIAE				
NUMBER of INGUINAL HERNIAE	NUMBER of SLIDING HERNIAE		PERCENTAGE	
1240	SIGMOID 18 CAECUM 9	27	2.17	
RECURRENCE				
CURED	RECURRED	DIED	NOT FOLLOWED	PERCENTAGE of RECURRENCE
16	4	1	6	20.0

type of herniae. It has been pointed out elsewhere that the visceral contents of these herniae may be accurately determined by the use of the bismuth enema. Positive evidence of either the sigmoid or the cecum should make the operator alert to the operative difficulties, and also to the possibilities of an operative accident.

With the knowledge that one is dealing with a sliding hernia, the operation may be considerably modified from that of the routine procedure. In such cases the sac should be opened as soon as possible in order to disclose its contents. The opening in the sac is best made close to the internal ring and only when the operator is sure that he is opening through free peritoneum. Reduction of the contents has been attempted most often in this series by the Hotchkiss[2] method. We have found this a simple and satisfactory procedure.

TABLE XI

HERNIAE COMPLICATED by STRANGULATION or IRREDUCIBILITY			
TYPE of HERNIA	OMENTUM	LARGE INTESTINE	SMALL INTESTINE
INGUINAL	68	6	25
FEMORAL	18	0	2
LATERAL VENTRAL (P.O.)	1	1	2
UMBILICAL	5	0	1
EPIGASTRIC	1	0	0
TOTAL	93	7	30
GRAND TOTAL 130 HERNIAE			

HERNIAE REQUIRING IMMEDIATE OPERATION because of ACUTE INTESTINAL OBSTRUCTION	
INGUINAL	18
FEMORAL	1
LATERAL VENTRAL (P.O.)	1
UMBILICAL	0
EPIGASTRIC	0
TOTAL	20 or 15.3% of 130

Scrotal herniae are very common in this older group of patients. In this series there were 184 such occurrences. They are generally of very large size and furnish the more difficult type of case to deal with operatively. While scrotal herniae are for the most part, indirect, there were, however, 12 cases of scrotal herniae that were direct herniae. One scrotal hernia containing the bladder occurred in this series. This patient's history elicited the fact that his hernia was always larger in the morning, after a night's sleep, unless he awoke to micturate during the night, whereupon his hernia diminished in size correspondingly.

The great majority of the above group (Table XI), which had large as well as irreducible herniae, precluded the possibility of the use of a truss, and the symptoms arising from the size of the hernia were so incapacitating as to need relief by the only available method, namely, operation.

The condition of the testicle as a result of, or as a sequela to, the operation

is frequently not noted carefully enough. The following percentage of incidence of atrophy was found in this series (Table XII):

It is quite probable that these figures understate the postoperative incidence of atrophy of the testicle following simple herniotomy or herniotomy with cord resection, as many of the surgeons at the time of the follow up examination failed either to notice or to make note of the size or the condition of the testicles.

TABLE XII

ATROPHY of the TESTICLE			
A-FOLLOWING OPERATION for INGUINAL HERNIA			
TYPE of HERNIAE	HERNIAE FOLLOWED	ATROPHIED TESTICLES	PERCENTAGE
PRIMARY INGUINAL	652	25	3.8
RECURRENT INGUINAL	90	14	15.5
TOTAL	742	39	Average 5.2
B-FOLLOWING DIVISION of the SPERMATIC CORD			
PRIMARY INGUINAL	75	17	21.3
RECURRENT INGUINAL	17	7	41.1
TOTAL	92	24	Average 26.0

Necrosis of Testicle Following Division of Spermatic Cord.—This complication has occurred in two out of 125 cord resections. Both of these

TABLE XIII

SUTURE MATERIAL				
INFECTION RATE				
TYPE of SUTURE	NUMBER of HERNIAE		NUMBER of INFECTIONS	PERCENTAGE
CATGUT	871		24	2.75
FASCIA	443		40	9.02
BLACK SILK	57		4	7.01
TOTAL	1371		68	4.95
RECURRENCE RATE				
TYPE of SUTURE	HERNIAE	FOLLOWED	RECURRENCES	PERCENTAGE
CATGUT	871	499	129	22.4
FASCIA	443	287	82	28.5
BLACK SILK	57	39	9	23.0
TOTAL	1371	825	220	26.6

patients suffered from infections which required removal of the necrosed testis about two weeks postoperatively. It has been pointed out that necrosis

of the testis only follows where the testis is disturbed from its normal attachments during the resection of the cord.

Visceral Injuries.—In this series of 1,371 herniotomies there were ten instances in which the contained hollow viscus was opened by the operator. The small intestine was opened three times, the cecum once, the sigmoid twice, and the bladder four times, respectively (Table XIV).

TABLE XIV

OPERATIVE COMPLICATIONS			
INTESTINE OPENED			
SEGMENT	TYPE of HERNIA	WOUND HEALING	REMARKS
SIGMOID	LEFT OBLIQUE INGUINAL	PRIMARY	RECOVERED
CAECUM	RIGHT DIRECT INGUINAL	INFECTED	RECOVERED NO FISTULA
SMALL INTESTINE	LEFT OBLIQUE INGUINAL	INFECTED	DIED - PERITONITIS
SMALL INTESTINE	RIGHT OBLIQUE INGUINAL	INFECTED	DIED - PERITONITIS
SMALL INTESTINE	VENTRAL	PRIMARY	CURED - 5 YEARS
SIGMOID	LEFT OBLIQUE INGUINAL	INFECTED	FECAL FISTULA HEALED 3 MONTHS CURED 2 YEARS
BLADDER OPENED			
RIGHT INGUINAL (RECURRENT)		PRIMARY	CURED 8 YEARS
RIGHT INGUINAL (RECURRENT)		PRIMARY	RECOVERED
RIGHT OBLIQUE INGUINAL		PRIMARY	RECOVERED
RIGHT DIRECT INGUINAL		INFECTED	DIED - PERITONITIS
TOTAL COMPLICATIONS - INTESTINAL - 6 - BLADDER - 4 - GRAND TOTAL - 10			

We feel that visceral injury in herniotomy, while a rare complication, is nevertheless a serious one. In this group of cases the bladder injuries were the least alarming. Of the four bladder wounds encountered during these operations, three were immediately and adequately closed with layer

TABLE XV

ANESTHESIA		
TYPE of ANESTHESIA	NUMBER of PATIENTS	PERCENTAGE
GENERAL	823	79.7
SPINAL	114	11.0
LOCAL	95	9.3
TOTAL	1032	100.0

suture, and primary union resulted. The bladder wound in the remaining case was so small that it escaped attention at the time of operation, and resulted in a fatality four days later. In our opinion, should one accidentally open the bladder, the important thing must be a careful exposure of the opening so that an adequate layer repair may be accomplished immediately.

Injuries to the intestines are attended by a greater hazard as shown in this small group. Such injuries were usually followed by infection and two out of three of the wounds of the small intestines were followed by infection with resultant fatality. The management of such an operative accident must be left to the judgment of the operating surgeon.

TABLE XVI

ASSOCIATED OPERATIONS

Genito-urinary Organs		Miscellaneous	
Hydrocele	25	Appendicectomy	6
Spermatocele	5	Hysterectomy	1
Orchidectomy	14	Meckel's diverticulum	1
Varicocele	3	Carcinoma of mouth	1
Cryptorchid	1	Uterine suspension	1
Circumcision	1	Perineorraphy	1
		Hemorrhoidectomy	4

TABLE XVII

INCIDENCE OF POSTOPERATIVE COMPLICATIONS

Genito-urinary		Pulmonary		Miscellaneous	
Hydrocele	20	Pneumonia	8	Hematoma	12
Urinary retention	1	Atelectasis	2	Psychoses	3
Orchitis	12	Bronchitis	4	Phlebitis, same side	1
Anuria	1	Bronchopneumonia	8	Phlebitis, bilateral	1
Cystitis	1	Pulmonary infarct	9	Phlebitis, opposite side	4
		Pleurisy	1	Cardiac failure	5
		Lung abscess and empyema	1	Uremia	1
				Ileus	5
				Myocarditis	3
				Peritonitis	3
				Paratyphoid	1

TABLE XVIII

DURATION OF FOLLOW-UP (CURED HERNIAE)				
TYPE of HERNIA	1-2 Years	2-3 Years	3-5 Years	5-10 Years
PRIMARY INGUINAL	489	355	269	150
RECURRENT INGUINAL	60	50	39	26
FEMORAL	27	17	10	7
LATERAL VENTRAL(PO)	14	12	11	6
UMBILICAL	11	10	5	2
EPIGASTRIC	3	2	1	1
INTERSTITIAL	1	0	0	0
TOTAL	605	446	335	192

Technic.—The operation of choice in the repair of inguinal hernia has, in practically all of the cases, been by the Bassini method or by the Bassini method with some one of many modifications. An attempt has been made to provide a strong posterior wall and in doing this, besides suturing the conjoined tendon to the shelving edge of the Poupart ligament, the transversalis fascia has in most cases been utilized, either with the conjoined tendon or

in a separate layer. The latter modification was more often made use of in direct herniae. The spermatic cord was usually transplanted, and in about 50 per cent of these cases the external oblique aponeurosis was sutured beneath the spermatic cord. The method of dealing with the sac was by transfixation as high as possible, removing that portion distal to the transfixion and sometimes suturing the stump of the sac posterior to the deep muscles. As mentioned previously, the sac of the sliding herniae was usually treated by modification of the Hotchkiss method. The repair otherwise followed the usual methods.

TABLE XIX

SUMMARY of 1371 HERNIAE in 1032 PATIENTS OPERATED UPON WHEN FIFTY YEARS of AGE or OLDER

TYPE of HERNIA	NUMBER of HERNIAE FOLLOWED	RECURRENCES	PERCENTAGE of RECURRENCES
PRIMARY INGUINAL	659	170	25.8
RECURRENT INGUINAL	91	31	34.0
FEMORAL	28	1	3.5
LATERAL VENTRAL (E.O.)	22	8	36.0
UMBILICAL	16	5	31.0
EPIGASTRIC	8	5	62.5
INTERSTITIAL	1	0	0.0
TOTAL	825	220	26.6

SUMMARY OF HERNIAE FOLLOWED			
CURED	605	MORTALITY RATE	2.9
RECURRED	220	INFECTION RATE	4.95
DIED (30 PATIENTS)	41		
TOTAL 866			
TOTAL HERNIAE 1371		PERCENTAGE FOLLOWED 63.1	

CONCLUSIONS

This analysis deals with the results of herniotomy in 1,032 patients, all of whom were more than 50 years of age. It is quite apparent that herniotomy in this group is a more serious procedure, from the risk standpoint, than that of the same operation in patients in the younger decades. The mortality rate of 3 per cent indicates that only by taking every precaution before, during, and after operation, can this rate be decreased.

In more than 10 per cent of these patients, operation is nonelective due to irreducibility and strangulation. In a still larger group, the patient, knowing the risks and possibilities of recurrence, will elect surgical interference after years of truss wearing.

The recurrence rate of 25 per cent in primary inguinal herniae and 34 per cent in recurrent inguinal herniae, respectively, may lead to erroneous

TABLE XX

ANALYSIS OF FATALITIES

Age	Sex	Condition of Patient before Operation	Operation and Findings	Anesthetic	Time of Death	Cause of Death
54	M.	Cardiac; wt. 300 lbs.	Cecum	Local	5 days	Cardiac failure and uremia
50	F.	Obese; good risk	Small umbilical	G. O. E.	8 days	Pulmonary infarct.
50	M.	Good risk	Bilateral direct	G. O. E.	11 days	Pneumonia
60	M.	Very large scrotal rt.	"Football size"	G. O. E.	2 days	Heart fail. and B. Pn.
67	M.	Wt. 230; nephritis	Large umbilical	Local	20 days	Cardiac failure
61	M.	Fair condition	Bilateral direct	G. O. E.	3 days	Paralytic ileus
55	M.	Good risk	Bilateral indirect	G. O. E.	8 days	Pulmonary embolism
56	M.	Chronic bronchitis	Bilateral indirect	Spinal	6 days	Lobar pneumonia
64	F.	Good risk	Left femoral inc.	Spinal	15 days	Bronchopneumonia
56	F.	Cardiac; B. P. 160/90	Left indirect	Spinal	14 days	Hemiplegia
55	M.	Good risk	Bilateral inguinal	Spinal	1 day	Cardiac failure
62*	M.	Strangulated 2 hrs.	Right oblique	Local	1 day	Peritonitis
55	M.	Good risk	Bilateral direct and L. F.	Local	5 days	Par. Il. and B. P.
63	M.	Hernia 20 yrs. Irreducible	Lt. indirect sld. Sigmoid	Spinal	10 days	Lobar pneumonia
58	M.	Good risk	Left indirect	G. O. E.	33 days	Pneumonia and lung abscess
60	F.	Irreducible for 10 hrs.	Left indirect very large	G. O. E.	1 day	Cardiac failure
63	M.	Good risk	Right indirect scrotal	G. O. E.	6 days	Pul. embolism
71*	M.	Strangulated 5 days	Left indirect rectal	Local	7 days	Hemiplegia
55	M.	Good risk	Bilat. direct sld. Blad.	G. O. E.	4 days	Injury to bladder
50*	M.	Strangulated 48 hrs.	Rt. femoral rec. Small int.	Local	2 days	Par. Il Dem.
54	M.	Good risk	Bilateral direct	G. O. E.	3 days	Pneumonia
65	M.	Very fat	Rt. direct R. sld. Cecum	Spinal	2 days	Bronchopneumonia
69	M.	Irreducible 72 hrs.	Lt. indirect, small gut	Spinal	16 days	Peritonitis
59	F.	Cardiac; nephritic	Lt. femoral irr. Oment.	Spinal	39 days	Cardiac failure
73	M.	General condition fair	Rt. direct R. and umbilical	Spinal	2 days	Pneumonia
54	F.	Cardiac	Umbilical	G. O. E.	9 days	Pulmonary infarct.
69*	M.	Strangulated sigmoid, 10 hrs.	Sigmoid	Spinal	3 days	Par. Il. B. Pn.
80*	M.	Strangulated small gut; senility	R. O. I. H. Gut open	G. O. E.	11 days	Peritonitis
58	M.	Good risk	L. O. I. H. and R. D. I. H.	G. O. E.	20 days	Bronchopneumonia
55	M.	Irreducible, rt. scrotal	Large intes. and oment.	G. O. E.	2 days	Terminal pneumonia

* Represents acute intestinal obstruction.

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conclusions. The operative result is judged by the two standards of anatomic (objective) result and symptomatic (subjective) result. The anatomic result may, if it is true, show a high recurrence rate. More than 50 per cent of these recurrences are very small, however, and the patient is completely unaware of the fact. These small recurrences, for the most part, are without symptoms. Therefore, it is correct to state that in many of these patients with a poor anatomic result, as judged by the presence of a small recurrence, the symptomatic result is often excellent. We cannot too strongly emphasize the disparity in many cases between the anatomic and the symptomatic results of the operation. While the operator may note in his follow up report many anatomic failures, the patient, however, in many of these same cases is impressed by his complete symptomatic relief.

REFERENCES

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DISCUSSION OF THE PAPERS BY DOCTORS BURDICK, COLEY, GILLESPIE, HIGINBOTHAM, PARSONS, GRACE AND JOHNSON

DR. FRANZ TOREK (New York) said that anatomic studies he made, more than 32 years ago, with the object of finding the causes of failure after the Bassini operation revealed the fact that every oblique inguinal hernia emerged from the abdomen, not on one side or the other of the cord, but directly through it, that is, it emerges between the vas deferens and the spermatic vessels and separates them at the internal inguinal ring. In line with this observation it seems natural to assume that the wedge shaped alignment of these two structures in their intra-abdominal course makes it easy for a force from within to exert itself at the point where the vas deferens, coming up from below, meets the spermatic vessels on their downward course. Therefore, if that be granted, would not the abolition of the wedge be indicated in order to obtain better results in the repair of oblique inguinal hernia?

The first picture,* from Spalteholz, a lateral view from within, shows the meeting of the vas and the vessels, and the second one shows the same from behind. The next is a diagrammatic representation of the direction of the force, showing how the parietal peritoneum insinuates itself into the open angle of the wedge, and in the next illustration the impinging peritoneum is depicted as having become a fully developed hernial sac.

To demonstrate the relation of sac, vessels and vas at the internal ring, it is necessary to remove all connective tissue, fat, *etc.*, which obscure the field. I usually start by dissecting the vas clear of connective tissue up to the internal ring, then proceed likewise with the vessels and the sac. All other parts of the cord at its upper end are removed, as they would hinder the accurate approximation of the transversalis and internal oblique to Poupart's ligament. The next illustration shows the sac emerging between the vas and the vessels. An imperfect dissection, with connective tissue stretching across, might make the sac appear to be behind, not between them.

* For illustrations referred to in text see ANNALS OF SURGERY, **70**, 67, July, 1919.

The aim of Doctor Torek's operation is to abolish the wedge-shaped alignment of vas and vessels, to keep these structures apart and to create a square buttress between them, as is shown in the next illustration, a diagrammatic longitudinal section, and again in the next picture, which shows the completed suture. You see the vessels placed as high up as possible and close to them a suture of No. 0 chromic gut approximating the internal oblique and transversalis to Poupart's ligament. The vas is placed at the lowest point of the internal ring, and a suture is inserted just above it. The number of sutures depends on the size of the opening.

This part of the operation takes care of the oblique hernia. Any protrusion below the vas deferens is a direct hernia. The suturing is continued down to the pubis, even if the patient does not actually have a direct hernia. Likewise, at an operation for direct hernia, the parts higher up should be carefully dissected, or else a small sac between vas and vessels may easily be overlooked. The picture shows four sutures inserted below the vas for the repair of the direct hernia. Of these the upper two are No. 0 chromic gut. At the lower end of this suture line the tension between Poupart's ligament and the rectus fascia is often too great to trust an absorbable suture to hold. As to the use of silk for the tension sutures, I know it will answer, for I used silk in many cases after I had developed the method in 1905, and never experienced any failure with it. I changed to silver because I was afraid of buried silk in case an infection should occur, whereas silver cannot be infected. In the picture you see that silver was used for the lowest two sutures. The manner of handling the silver is shown in the next diagram. The wire is twisted on the side of the muscle, not at Poupart's ligament, and the cut end is embedded in the muscle where it will do no harm. However, the suture material has nothing to do with the technic which is described except insofar as to warn against absorbable material for suturing the rectus fascia to Poupart's ligament if there is great tension. I do not employ anything but absorbable material in children, as their tissues are yielding. The same is true in the majority of cases in women. Silver has served me very well. Some years ago I had a case of hernia reaching to within four inches from the knee. After a very difficult replacement the pressure from within was so great that I decided to use silver throughout. A few days later the scrotum was again greatly distended and gave a tympanitic resonance, so that I thought it contained intestine. However, it turned out to be a gac bacillus infection. The wound was widely opened, down to the silver sutures. It was packed and allowed to heal by granulation. The hernia remained cured. I doubt whether woven material would have resisted the infection so well.

As to results, 598 cases that could be traced were reported before the New York Surgical Society in March, 1919. The most recent patient had been operated upon two years previously. There were two recurrences. Of these, one developed gangrene, supposedly of syphilitic origin, while still in the hospital. A Wassermann test was not made until we saw the gangrene. The cause of the other I could not determine, as I was not present at the operation. I can only say that the intern who performed it never turned out to be a surgeon. Last year Doctor Sauer told me of another recurrence which had occurred in the same series, also operated upon by an intern who did not develop into a surgeon. That makes three recurrences out of 598 cases, or one-half of one per cent. Since the termination of my ward service at the Lenox Hill Hospital, Doctor Muehleck has kept watch over the hernia

cases in the Follow Up Clinics. He told me that during those 11 years he had not seen any recurrence after my operation. In my private practice I also have had no recurrences.

Dr. Fenwick Beekman (New York) thought that one or two additional points should be brought out. In most statistics relative to hernia cases it is found that the percentage of recurrences is much lower in oblique herniae than in direct, as in these series children, young adults, and old people are included. In other words, there are included in these series a large number of individuals who do not, and cannot, develop a direct hernia, and the percentage of recurrence of the direct is compared with that of the indirect herniae on equal terms. Doctor Grace has shown, by comparing individuals over 50, the true relationship between the recurrence rate in oblique and direct herniae. He gives in the oblique a percentage of 21, and in the direct 34, figures that are much more nearly correct than those we find in most hernia statistics. There is no doubt that the data that have been gathered together in this symposium are as honest as possible. Doctor Beekman expressed his conviction that silk is the ideal suture material because it does not irritate, as Doctor Parsons emphasized. All that is necessary to prove its less irritating properties is to examine, at the end of ten days, the wounds of a case in which silk has been used on one side and catgut on the other. Induration will be found on the side on which catgut has been used and none on the side where silk has been employed.

Dr. H. M. Gillespie (New York) said that he had worked on the statistics for fascial sutures for a number of years and had at times been very much discouraged by the results in operations for recurrent and direct hernia at Ruptured and Crippled Hospital in the early days. Recurrence was from 50 to 60 per cent then, and in less with fascial repair, but the elements of the silk technic give more assurance for the cure of the particularly difficult cases due, for one reason, to the very essential lack of tension. In many cases of fascial repair it was necessary to employ a great deal of tension which does not favor full, strong healing.

Dr. Wm. Barclay Parsons (New York) in closing said that he thought that the rules laid down originally by Halsted still held true. One of the most important is the question of the fineness of the material. Experience with the use of linen was very striking. Wounds sutured with heavy braided silk, years ago, did badly; that silk was very strong and thick. Those sutured with linen likewise did not do well. The material must be fine and the needle used must be small in order not to make big wounds in the various layers being sutured together. Small pointed hemostats must also be used, and in tying off great masses of tissue one must be careful about contamination. Every individual, every orderly, in fact everyone coming in even to bring a message, must be masked. The importance of this was emphasized by Meleney some years ago in his studies of a series of wound infections. In an infected wound, obviously, silk must not be used, but in a clean wound it is of real value. Fine silk is easily handled and the disadvantages are minimal. Doctor Parsons emphasized that the series he reported does not compare fairly with Doctor Grace's series because it did not include children and it included comparatively few elderly people.

RECURRENT INGUINAL HERNIA

AN ANALYSIS OF TWO HUNDRED OPERATIONS

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THIS review of 200 recurrent inguinal hernia operations performed at the Henry Ford Hospital during the 15 year period 1920–1934, inclusive, was prompted by our recent inquiry into the recurrent rate for primary hernia operations. The rate of 8.25 per cent obtained in the latter was increased by 50 per cent in the former, where it was found that the second repair was unsatisfactory in 26, or 13 per cent, of the 200 operations for recurrent inguinal hernia. Multiple operations for recurrent hernia were performed in ten cases in this series. In nine of them, the operation recorded was for the repair of a second recurrence, with one failure and, in one instance, a successful result attended the fourth attempt at repair. The term "recurrent hernia" in its narrowest sense implies the return of exactly the same type of hernia as existed before operation. Since true recurrences are relatively rare, the designation "recurrent" as here employed embraces all types of inguinal protrusions occurring after hernioplasty. Because of the difficulty of determining clinically the exact nature of the recurrence, whether it is direct or indirect, or even only a protrusion of preperitoneal fat without any true sac formation, it seems better to continue the use of the term "recurrent hernia" in its broadest sense. From the patient's point of view, the technical description is unimportant; what interests him is the fact that he is unable to obtain employment.

Follow Up.—The follow up, as shown in Table I, was not particularly effective because of the difficulty of tracing a group of patients drawn, for the most part, from a changing industrial population. However, there is not likely to be a great discrepancy in the figures as a result of this, since a patient who has subjected himself to two operations is likely to be hernia conscious and to return for check up should there be signs of a second recurrence.

Age Incidence.—Seventy-eight per cent of recurrences were in the fourth and fifth decades of life, or between the ages of 30 and 50, a period of great physical activity at a time in life when there is decreasing muscular tone.

Sex Incidence.—There were three females in the series, a percentage of 1.5 Recurrence in the female can certainly be laid to surgical error, since the inguinal canal can be completely obliterated.

Occurrence of Obesity.—Ten of the patients, or 5 per cent of the series, were recorded as being overweight. Increased preperitoneal fat is a factor in the production of direct hernia, since the laying down of fat between the

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peritoneum and the transversalis fascia leads to stretching and weakness of the latter structure. The mechanism is apparent when it is recalled that fat in the body is a liquid or a semisolid substance and thus is a suitable medium for the transmission of the forces of gravity and intra-abdominal pressure. This also explains how large masses of preperitoneal fat found external to the transversalis fascia have made their way through apparently small apertures.

TABLE I

TIME INTERVAL OF RECURRENCE OF HERNIA

Time Elapsed Since Operation	No. of Patients	Percentage
Under 6 mos.	82	41.0
6 mos.–1 yr.	14	7.0
1–2 yrs.	29	14.5
2–3 yrs.	29	14.5
3–4 yrs.	15	7.5
4–5 yrs.	16	8.0
5–6 yrs.	7	3.5
6–7 yrs.	5	2.5
7–8 yrs.	1	0.5
8 yrs. plus	2	1.0
Total.....	200	100.0

TABLE II

AGE INCIDENCE OF RECURRENCES

Decade	Age	No. of Patients	Percentage
1	1–10	1	0.5
2	11–20	2	1.0
3	21–30	17	8.5
4	31–40	69	34.5
5	41–50	87	43.5
6	51–60	20	10.0
7	61–70	4	2.0
8	71–80	0	0.0
Total.....		200	100.0

Nature of Occupation.—The type of work engaged in by the individual after operation has a decided influence on the question of recurrence. Table III shows that 92 per cent of the patients in this series had occupations which entailed heavy lifting and straining, while only 8 per cent of the recurrences were in patients whose occupations were sedentary in character. Further evidence of the influence of occupation is obtained by noting that 71 patients, or 35.5 per cent of the series, gave a definite history of injury preceding the appearance of the recurrence.

TABLE III

NATURE OF OCCUPATION

	No. of Patients	Percentage
Hard labor	184	92.0
Sedentary occupations	16	8.0

Time Interval of Recurrences.—A study of Table IV denotes the futility of attempting to arrive at a percentage rate of the time interval of recurrences without an adequate follow up. Here it is shown that 77.5 per cent of the recurrences took place more than six months after the operation, and in 52 per cent of patients there was no evidence of recurrence until more than three years had elapsed. Admittedly some of these patients had signs of recurrence before it was recorded. But even making allowance for this, the point which we have emphasized before is well brought out. In this series second recurrences appeared much earlier for, as is shown in Table V, of the 26 such operative failures 20, or 80 per cent, were recognized within one year of the second operation.

TABLE IV

TIME OF FIRST RECURRENCE

	No. of Patients	Percentage
Up to 6 mos.	45	22.5
6 mos.–1 yr.	31	15.5
1–2 yrs.	20	10.0
2–5 yrs.	39	19.5
5–10 yrs.	28	14.0
10 yrs. plus	37	18.5
Total	200	100.0

TABLE V

TIME OF SECOND RECURRENCE

	No. of Patients	Percentage
1–6 mos.	8	30.8
6 mos.–1 yr.	12	46.1
1–2 yrs.	1	3.9
2–5 yrs.	4	15.3
5 yrs. plus	1	3.9
Total	26	100.0

Duration of Recurrence Before Operation.—The present day tendency to have even recurrent herniae repaired early is indicated by reference to Table VI, where it is shown that 26.5 per cent or more than one-quarter of the patients were operated upon within one month of the recurrence of their hernia, and 66.5 per cent or two-thirds of the group before a year had elapsed. This serves to draw attention to the increasing importance of hernia as viewed from an industrial standpoint. Formerly if an operation for hernia proved to be unsuccessful, the individual, dissatisfied with his experience of surgery, suffered the inconvenience of the condition for the remainder of his life.

But nowadays, since it is becoming increasingly difficult for the ruptured man to obtain employment, the trend is toward repeated operations.

TABLE VI

DURATION OF RECURRENCE BEFORE OPERATION

	No. of Patients	Percentage
1 mo.	53	26.5
1–2 mos.	15	7.5
2–6 mos.	31	15.5
6–12 mos.	34	17.0
1–2 yrs.	22	11.0
2–6 yrs.	16	8.0
6 yrs. plus	29	14.5
Total	200	100.0

The increased liability of left sided hernia to recur was mentioned in a previous communication[2] where, in a series of 1,600 primary hernia operations, it was noted that 57.6 per cent of the recurrences were on the left side and only 42.4 per cent on the right side. This is an interesting observation and is all the more striking when it is recalled that the right side is more often involved in hernia in the ratio of three right to two left. It has been a frequent observation that, following operations for bilateral herniae in which both sides have been repaired at one sitting, recurrences are more likely to occur on the left than on the right side, and all the more so if the left side happened to have been the last repaired. We have attempted to explain this fact because in bilateral hernia operations, the element of fatigue may enter and, therefore, the surgeon may be prone to be less thorough in his repair. When the herniae are of unequal size, the larger side is, of course, operated upon first, but when the sacs are approximately of the same size, as is so often the case in direct herniae, the right side is usually repaired first, since most surgeons are more accustomed to working on the right side. Another and perhaps more important item, is the difficulty experienced in obtaining sufficient tissue to close, without tension, the inguinal canal on the opposite side. This is especially noticeable in direct herniae, in which the conjoined tendon is so frequently rudimentary or absent, that the sheath of the congenitally narrow rectus muscle must be utilized to effect approximation of the tissues. When the surgeon proceeds to repair the opposite side, he finds his difficulties have increased and the effectiveness of his operation correspondingly decreased. Furthermore, if imbrication of the aponeurosis of the external oblique muscle is practiced, difficulty in obtaining sufficient aponeurosis to permit overlapping will be found on the opposite side.

TABLE VII

RELATIVE FREQUENCY OF THE SIDE INVOLVED

	No. of Patients	Percentage
Right side	93	46.5
Left side	107	53.5

Table VIII shows only 38.5 per cent of recurrent hernia operations performed under spinal anesthesia. This does not give a true picture because spinal anesthesia has been in general use for only a portion of the period covered by this series. It is our practice to use spinal anesthesia in all hernia operations provided there is no contraindication to its use. Thus, fully 90 per cent of our herniotomies at the present time are performed under spinal anesthesia. The perfect relaxation afforded by spinal anesthesia permits the utilization of all available tissue without tension, an item of the utmost importance in plastic repair.

TABLE VIII

ANESTHESIA

	No. of Patients	Percentage
Spinal	77	38.5
Ethylene and ether	62	31.0
Ether	22	11.0
Ethylene	21	10.5
Nitrous oxide and ether	12	6.0
Avertin and ethylene	3	1.5
Local	3	1.5
Total	200	100.0

Transplantation of Cord.—The spermatic cord was found to have been transplanted in 40 patients, or 20 per cent of the series. Failure to transplant the cord was responsible for some of the recurrences in our own cases because adequate support cannot be provided for the transversalis fascia if the cord is left in situ. From a strictly technical point of view, isolation of the cord at the second operation is much more readily accomplished and there is less likelihood of injuries to the structures when transplantation has not been done.

Type of Recurrence.—There was almost an equal number of direct and indirect recurrences in this series; *i.e.*, 99 direct and 101 indirect. An interesting point is brought out here. Of the 53 recurrences in patients originally operated upon at this hospital, there were 38, or 71.7 per cent, of this group who had direct recurrences and 15, or 28.3 per cent, of the group who had indirect recurrences, while of the 147 recurrences in patients in whom the first operation had been performed elsewhere, 61, or 41.5 per cent, of this latter group had indirect recurrences. These statistics would suggest that in our own cases we were neglecting the factors which tend to prevent the appearance of a direct hernia and, on analysis, this would appear to be true for, as we have shown elsewhere, 88.6 per cent of our hernial repairs were effected without transplantation of the cord. As a direct result of this study, we are now transplanting the cord in a greater percentage of cases. Indirect recurrence is primarily due to failure to obtain a high ligation of the sac and direct recurrence is due to failure to provide adequate protection

to the floor of Hesselbach's triangle, which usually means failure to recognize the importance of the transversalis fascia.

Size of the Sac.—In 18 cases, or 9 per cent of the series, there was no

TABLE IX

TYPE OF RECURRENCE

	First Operation at Henry Ford Hospital		First Operation Elsewhere		
	No. of Patients	Percentage	No. of Patients	Percentage	Total
Direct.....	38	71.7	61	41.5	99
Indirect.....	15	28.3	86	58.5	101
Total....	53	100.0	147	100.0	200

sac found at operation. The bulging in the groin was due to pads of fat, either preperitoneal extrusions through the transversalis fascia, or localized collections in the coverings of the cord, the so called lipomata of the cord. This condition simulates recurrence and inasmuch as these cases require operation, they are included with the recurrent herniae.

TABLE X

SIZE OF THE SAC

	No. of Patients	Percentage
Large....	56	28
Small.....	126	63
None.....	18	9

Sliding Hernia.—There were 11 cases of sliding hernia, a percentage of 5.5. All these were repaired without resorting to intra-abdominal fixation of the pelvic colon. The difficulties of making a high closure of the sac in this type of hernia necessitates providing additional protection to the region of the internal ring by not transplanting the spermatic cord.

The Plastic Repair.—The problems confronting the surgeon in the repair of a recurrent inguinal hernia differ but little, fundamentally, from those obtaining at the primary operation. In both, disposition must be made of, that greatest of all obstacles to cure, the spermatic cord and its covering. Should Hesselbach's triangle be given the greatest possible support, by transplanting the spermatic cord, or must we provide the additional protection to the internal ring as afforded by the Ferguson or Halsted type of repair? These are the questions to be answered if an effective operation is to be carried out.

In spite of the fact that the repair of a recurrent hernia is admittedly more difficult, the surgeon performing the operation has the great advantage of being in a position to profit by his predecessor's errors. This is notably true when the surgeon has the occasion to operate upon a recurrence in one of his own patients. The opportunity to obtain a postgraduate course in hernioplasty is open to those who will focus an inquiring, unbiased mind on the reason or reasons for failure of the primary operation. There is no knowledge to be gained or no advance to be made by attributing failure

to the usual causes of poor structures, faulty suture material, or too early return to work, *etc.* Countless successful operations have been performed upon patients in whom one or all of these factors obtained. The assertion that all inguinal herniae can be cured by operation is amply evidenced by the fact that three or even four recurrences have been satisfactorily repaired. This suggests that the real cause of recurrence lies in a technical error at the primary operation, for if the factors predisposing to recurrence had been recognized then, and adequate steps taken to circumvent them, the first operation would have been as satisfactory as the last.

Closure of the Sac.—The method adopted for closure of the sac is in part an index of the extent of the recurrence and the difficulties of repair. Twisting and transfixion of the sac are possible only when the sac is small and narrow, while the purse string closure can be used on herniae of moderate size. The use of the straight suture indicates either a large mouthed sac or bulging of the peritoneum along the full length of the canal. In 15 cases, or 7.5 per cent, the peritoneal cavity was not entered, either because there was no sac discovered or because there was only a generalized weakness of the whole canal. The peritoneum should be opened in all cases, without fail, because we believe this is the only method whereby a sac will not be overlooked. The easiest and best portal of entry to the peritoneal cavity is at the internal ring as recommended by Hoguet,[8] a maneuver carried out in 16.5 per cent of cases in this series.

The Transversalis Fascia.—This important structure should be examined in all hernia operations for, as Moschowitz pointed out, it is the only structure in the abdominal wall through which all herniae pass. The omission of this step is mainly responsible for the appearance of direct recurrences after operation for indirect inguinal hernia. The transversalis fascia forming the floor of Hesselbach's triangle is completely ruptured in all cases of direct hernia. It is weakened and stretched in the obese, the middle aged, and in those with large necked indirect herniae, a condition which

TABLE XI

CLOSURE OF THE SAC

	No. of Patients	Percentage
Straight suture....	77	38.5
Purse string.....	60	30.0
Twisting.....	31	15.5
Transfixion.....	17	8.5
Not opened.....	15	7.5
Total.....	200	100.0

is often not apparent unless specific investigation of this structure is made. Repair of the fascia is effected by a series of purse string or reduplication sutures taking up the slack in minor degrees, but when separation is complete the torn margin should be united to the shelving edge of Poupart's ligament with interrupted sutures for the entire length of the inguinal canal.

Special care should be taken at the internal ring to close the fascia snugly around the spermatic cord.

Type of Repair.—The Bassini type of repair includes all cases in which the cord was transplanted either as in the original Bassini method or one of its modifications, such as closing all the structures of the abdominal wall including the aponeurosis of the external oblique muscle beneath the cord. This modification was employed in 33 per cent of the cases. The Halsted type is that in which the cord was not transplanted. The Bassini operation was the operation of choice, as is indicated by its use in 76.5 per cent of the total cases. The Halsted operation is suitable only for the repair of small indirect recurrences and for those occasions when a high ligation of the sac cannot be obtained; as for example, in instances of sliding hernia. The percentages of 13.7 failure for the Bassini operation and 10.7 failure for the Halsted operation as shown in Table XII should not be construed as indicating the comparative results of the two operations, since the Bassini operation was employed in the most difficult cases.

TABLE XII

TYPE OF REPAIR AT SECOND OPERATION

Type of Repair	No. of Patients	Percentage	No. of Recurrences	Percentage
Bassini	153	76.5	21	13.7
Halsted	47	23.5	5	10.7
Total...	200	100.0	26	13.0

Suture Material.—Silk was used as a suture material in 96 per cent of the cases. Catgut was used in only 4 per cent. Therefore no comparison of their relative merits can be made. Fascial sutures were not employed in any of the cases of this series, but as a result of the large number of operative failures, we are now using living sutures of fascia lata in cases where the structures are poor, in multiple recurrences, and where there has been loss of tissue from infection.

TABLE XIII

SUTURE MATERIAL

Material	No. of Patients	Percentage
Silk.....	192	96.0
Catgut.....	8	4.0
Fascial sutures....	0	0.0

Postoperative Complications.—The statistics in Table XIV do not merit comment other than to point out that the relatively high incidence of pulmonary complications, 3.5 per cent, had no appreciable effect on the success or failure of the operation.

TABLE XIV

POSTOPERATIVE COMPLICATIONS

Complications	No. of Patients	Percentage
Pulmonary complications	7	3.5
Hematoma	3	1.5
Testicular atrophy	3	1.5
Hydrocele	1	0.5
Phlebitis	1	0.5
Wound infection	1	0.5
Mortality	0	0.0
Total	16	8.0

There were 26 operative failures in the series of 200 operations; a rate of recurrence of 13.0 per cent. There were twice as many failures in cases previously operated upon in this hospital as in those whose primary operation was performed elsewhere. This may be attributed to the fact that in our own cases 71.7 per cent of the recurrences were direct while there were only 41.5 per cent of direct recurrences in the latter group. A consideration of this observation suggests that we have not been fully cognizant of the factors which bring about direct recurrence. However, as a direct result of this review, we are now emphasizing the importance of the transversalis fascia in repair, practicing imbrication of the aponeurosis of the external oblique beneath the transplanted cord, and using living sutures in selected cases because we believe that at least some of our failures have been due to lack of appreciation of the value of these operative steps.

TABLE XV

RESULTS OF OPERATION FOR RECURRENCE

	Total No. of Patients	No. of Recurrences	Percentage
Primary operation (elsewhere)	147	15	10.2
Primary operation (H. F. H.)	53	11	20.8
Total	200	26	13.0

SUMMARY

(1) Two hundred cases of operation for recurrent hernia are reviewed.
(2) There were 26 operative failures; a rate of recurrence of 13 per cent.
(3) Seventy-eight per cent of the recurrences occurred in patients between the ages of 30 and 50.
(4) Ninety-two per cent of the patients were engaged in heavy labor.
(5) Seventy-five per cent of recurrences appeared more than six months after the first operation.
(6) Recurrence is more frequent on the left than on the right side.
(7) The importance of the transversalis fascia is stressed.

The counsel of the Surgeon-in-Chief, Dr. Roy D. McClure, is gratefully acknowledged.

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SUBPARIETAL RUPTURE OF THE INTESTINE DUE TO MUSCULAR EFFORT

A COMPLICATION OF HERNIA

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BOWEL rupture beneath an intact abdominal wall has been a subject of considerable surgical interest since the earliest attempts at intraperitoneal surgery by reason of its emergency nature. The association of internal injuries with penetrating abdominal wounds was known by the early military surgeons, and it was soon recognized that not infrequently nonpenetrating injuries of the abdominal wall were likewise associated with visceral injuries often of much greater magnitude than the external evidences would indicate.

Longuet[1] was the first to study the pathogenesis of subparietal bowel rupture, and concluded, from experimental work on the cadaver, that crushing of an intestinal loop between the offending force and the vertebral column or pelvis was the most important mechanism involved.

Moty[2, 3] distinguished between the three modes by which traumatic intestinal rupture occurred, and described the characteristics of each type. His classification, still followed today, differentiated between ruptures produced by éclatement (bursting), écrasement (crushing), and déchirure (tearing).

Petry,[4] who collected 262 cases of intestinal rupture without external wounds, elaborated on Moty's classification by differentiating those cases of bursting rupture due to muscular effort alone from those due to direct external violence. He was able to find three instances of the former type in the literature. Sauerbruch[5] made an exhaustive experimental study of the conditions necessary for bursting rupture of the intestine which he formulated as follows:

(1) Marked distention of bowel.
(2) Closure of a loop of bowel on both sides:
  (a) by kinks at two places,
  (b) by a kink at one place and closure by trauma at a second place,
  (c) by a double acting trauma closing the intestine at two places simultaneously.
(3) Contusion of the abdomen in the region of the distended loop.

Sauerbruch himself realized, however, that these postulates were inadequate to explain those ruptures without external violence which he somewhat vaguely attributed to a sudden marked increase in intra-abdominal pressure.

Bunge[6, 7] first pointed out that ordinarily the increased intraperitoneal pressure, produced by contraction of the abdominal muscles and diaphragm,

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could not in itself result in intestinal rupture by reason of the fact that that increased pressure is transmitted equally to all parts of the bowel wall, thus affording no point at which the bowel wall could rupture. He also indicated that if a loop of bowel were so placed that one of its walls were not exposed to the increased intraperitoneal pressure, then, and then only, would the bowel wall rupture at the unprotected site. Such a condition would obtain if an intestinal loop were to lie against one of the openings in the abdominal cavity such as a hernial ring or a hiatus for the entrance or exit of intra-abdominal organs through the diaphragm or pelvic floor. He supported these well conceived theoretical considerations by citing two personal cases in which he demonstrated the fact that the perforated loop of bowel lay adjacent to the internal ring of an inguinal hernia.

Haim[8] stated several years later that Bunge had erred in his concept of intraperitoneal pressure because the peritoneal cavity is in fact merely a potential space and as such can have no pressure of its own. He conceived of the intestinal tract as a single cavity, functionally speaking, of which the intestinal wall and the abdominal parietes merely form two concentric layers of the limiting wall. The intra-abdominal pressure is not intraperitoneal but rather endovisceral in its manisfestation and, under normal circumstances, is made to equal atmospheric pressure by the degree of tone of the abdominal musculature. When there is a sudden contraction of the muscles, the bowel is compressed and the endovisceral pressure raised. If, then, the visceral wall (in its broad sense, including both layers) is weaker at any one point (*i.e.*, at a hernial ring or hiatus), bowel rupture will occur at that point.

This concept might perhaps best be illustrated by comparison to a football which is composed of an inner weak rubber bladder and an outer tough leather coat. If the bladder is completely invested by the leather coat, the bladder will not rupture even if great pressure is brought to bear upon it. If, however, there is a defect in the leather coat at one point, pressure applied anywhere to the football would result in increased intrabladder pressure with prolapse of the bladder wall at the point of the parietal weakness and eventual rupture at this point. If, then, we consider the internal hernial rings and the various hiatuses as weak points in the outer layer of the endovisceral cavity, we can understand how increased endovisceral pressure may result in intestinal rupture at one of these points.

It may be noted here that the evagination of the intestinal wall need not necessarily proceed to the point of rupture, but may be sufficient to produce irreversible bionecrotic changes in the bowel wall with secondary local gangrene and subsequent late perforation. This appears to be the explanation of the sequence of events in Bunge's third case.[7] It is also conceivable that the evaginated bowel wall remain incarcerated at the neck of the hernial sac and produce the familiar Richter type of hernia.

Other theories as to the pathogenesis of intestinal rupture have been advanced by other writers. Bronfeldt[9] believed that muscular contraction in very powerful individuals could result in a compressive rupture of a loop

of bowel caught between the retracting anterior abdominal wall and the spine. Goebel[10] stated that perforation of normal bowel wall by Ascaris and Oxyuris worms has been demonstrated and that a partial perforation on this basis might be rendered complete by slight abdominal trauma. Taylor[11] felt that the perforation could be produced by compression of the contracting abdominal wall against a sharp foreign body within the intestine, which is thus made to force its way through the bowel wall. Duchaussoy[12] believed that muscular contraction bears no causal relationship to intestinal rupture, which he attributed to a coincidental perforation of a "simple" ulcer. The entire subject of simple ulcer of the intestine, which is closely related to our own, is well reviewed in the paper by Grasmann.[13] While Duchaussoy's explanation may apply in rare isolated cases, such as that of Kronlein,[14] it does not appear likely in those cases we have included in our series.

The question as to the necessity for preëxistent disease of the bowel wall as a prerequisite to perforation is by no means merely an academic one, for it was on this point that the determination of compensability in industrial accidents has been argued. In the case reported by Köhler[15] it was held by the compensation board that rupture of normal bowel wall by muscular effort alone is not possible, and that there must have been underlying pathology at the site of rupture. Subsequent writers[16, 17] have shown that rupture can occur in normal bowel wall and that such an accident is therefore rightly a compensable one. This was the decision in our own case.

Case Report.—An adult, white male accustomed to heavy work had known for the preceding four years of the presence of a left inguinal hernia which had been apparently well controlled by a truss. One day, about one-half hour after eating, he was helping to lift a 150 pound stone and was suddenly seized with severe pain in the left lower abdomen. He was forced to sit down, and shortly thereafter complained of nausea. He was immediately sent to the hospital where physical examination revealed abdominal tenderness and rigidity throughout, especially on the left side. There was an easily reducible left inguinal hernia with a point of extreme tenderness directly above the inguinal canal. The patient was observed for a period of 24 hours before being operated upon. Left herniolaparotomy was performed and the hernial sac found to contain no viscera. There was an extravasation of intestinal contents and straw colored fluid in the abdominal cavity. The origin of the peritonitis was seen to be an oval rupture of midjejunum about one-half inch long with its long axis parallel to that of the bowel. The perforation was closed and the abdomen drained. Death occurred on the first postoperative day.

In view of the rarity of this lesion and the consequent lack of extensive personal experience with it by any one observer, we have made an analytical review of all reported cases, and have drawn some conclusions as to pathogenesis, clinical features, and therapy.

CASE REPORTS OF 42 INSTANCES OF SUBPARIETAL RUPTURE OF THE INTESTINE CAUSED BY MUSCULAR EFFORT

*Abstracted from the Literature**

Case 1.—Scarpa:[25] A 26 year old soldier who had had a right inguinal hernia since

* We have included case reports from all sources with the exception of certain Russian references which are not available in this country. These are appended in the bibliography for the sake of completeness.[18, 19, 20, 21, 22, 23, 24]

his infancy but had supposed himself cured for several years felt it reappear during a violent effort in drawing the chain of a drawbridge. The following morning the scrotum was enormously distended and moderately painful. Vomiting had commenced a few minutes after the accident but had afterwards abated. Herniotomy performed two days later revealed the sac to contain a loop of ileum and colon (cecum?), the latter structure presenting a perforation about 1 cm. in diameter. The edges of the perforation were prolapsed and through it intestinal contents were being emitted. The point of rupture was sutured but the patient died on the fourth postoperative day from gangrene of the ilial loop which had been incarcerated. At the postmortem examination no other lesions of the gastro-intestinal tract were demonstrable.

Case 2.—Duguet:[26] A 60 year old man, previously in excellent health, while passing over a barrier, felt a sharp pain in the right side and could not walk any farther. This was followed by diffuse abdominal pain and vomiting, which continued until admission to the hospital the next day. Physical examination revealed signs of diffuse peritonitis. There were bilateral small direct herniae. The right hernial sac was opened with the escape of purulent fluid and gas indicating intestinal perforation and peritonitis. The wound was closed without further exploration. Death occurred four hours after operation. The postmortem examination revealed an oval perforation on the antimesenteric border of the ileum two feet above the iliocecal junction. The borders of the perforation were clean and presented no alteration other than a surrounding ecchymosis. There were no anatomic evidences of typhoid infection or of tuberculosis, and no foreign body was found.

Case 3.—Lespiau:[27] A 31 year old soldier, previously well, experienced severe lower abdominal pain and vomiting while straining at stool. He was admitted to the hospital the next day where he was treated conservatively for peritonitis. Exitus nine days later. Necropsy: Diffuse purulent peritonitis secondary to a perforation of the ileum 70 cm. above the ileocecal junction. The remainder of the gastro-intestinal tract presented no other significant findings.

Case 4.—Kaczorowski:[28] "A healthy robust man died one day after he lifted a heavy weight and strained himself. Autopsy showed a rupture of intestine of which the cause appeared to be the increased abdominal pressure incident to the exertion."

Case 5.—Moritz:[29] A 44 year old man, while lifting a very heavy weight, experienced sudden "bursting" pain in the abdomen. Physical examination revealed abdominal rigidity. Patient refused hospitalization and died. Necropsy: Diffuse peritonitis secondary to a perforation of the ileum four feet above the ileocecal junction. There was no anatomic evidence of an underlying ulcerative process.

Case 6.—Mikulicz:[30] A 40 year old cattleman, previously well, experienced severe lower abdominal pain on jumping to his feet suddenly from bed. This was followed by vomiting and obstipation, which persisted for three days until the patient was hospitalized. Physical examination revealed the signs of peritonitis and an incidental right inguinal hernia. Laparotomy revealed diffuse peritonitis secondary to a perforation on the antimesenteric border of the ileum. The mesenteric nodes were enlarged to the size of hazel nuts and were of soft consistency. The margins of the perforation were excised and an enterorrhaphy effected. Recovery ensued. Microscopic examination of the excised tissue revealed no specific changes. Although the author considered this to be a case of perforated ulcer in a "walking typhoid," there is no clinical or pathologic evidence in support of this diagnosis and the perforation is more probably related to the inguinal hernia noted on examination.

Case 7.—Lower:[31] A 63 year old laborer, while lifting one end of a 24 foot plank, experienced sudden pain in the left groin followed by vomiting. There was no evidence of hernia on physical examination, although this was suspected. The ileus was treated conservatively but the patient died two days after the accident. Necropsy revealed a diffuse peritonitis secondary to a perforation near the antimesenteric border of the ileum six feet above the ileocecal junction. There was no anatomic evidence of underlying

ulceration and the remainder of the gastro-intestinal tract presented no other significant findings.

Case 8.—Socin:[32] A 57 year old barrel maker who had worn a truss for a right inguinal hernia for the past two years had been well until, on lifting a heavy cask, he felt his hernia come out under the truss and then reduce itself. This was accompanied by intense pain, vomiting, and obstipation. On admission to the hospital three days later he presented marked abdominal tenderness, distention, and rigidity throughout. The inguinal regions were free. Immediate laparotomy revealed a localized peritonitis in the right iliac fossa. Drains were inserted without further exploration. Death occurred three days later. The postmortem examination revealed a local and general peritonitis secondary to an ileal perforation 25 cm. above the ileocecal junction. The mesentery of the involved loop of bowel exhibited many white stellate scars.

Case 9.—Thommen:[33]* A 52 year old barrel maker with a reducible inguinal hernia, well controlled by a truss, was seized with abdominal pain during a severe effort. The patient noted that the hernia came out under the truss during the effort and reduced itself immediately thereafter. This was followed by frequent vomiting and constipation. Physical examination on admission to the hospital two and one-half days later revealed diffuse abdominal distention and rigidity. There was marked tenderness in the ileocecal region. Liver dulness diminished. Laparotomy revealed a walled off abscess cavity in the right iliac fossa. This was drained without further exploration. Exitus two days after operation. Necropsy: Peritonitis fibrinosa in the right lower abdomen and pelvis. A round perforation was found on the antimesenteric border of the ileum 25 cm. above the ileocecal valve. The borders of the perforation were thick and the surrounding mucous membrane was of a bluish red color.

Case 10.—Neumann:[34] ("Exact history lost.") A 40 year old milk dealer, while lifting a heavy barrel, experienced abdominal pain. Twenty-four hours later he was brought to the hospital with evidence of diffuse peritonitis, and promptly operated upon. A general peritonitis secondary to a perforation of the bowel was found. Enterorrhaphy and peritoneal drainage performed. Exitus occurred one day after operation.

Case 11.—Bonanome:[35] A 37 year old driver, previously well except for occasional diarrhea. On jumping down two feet from a carriage he landed on his heels with a loss of equilibrium which he recovered by a sudden severe muscular effort. He immediately experienced lower abdominal pain, nausea, vomiting, and mental confusion. Physical examination one and one-half hours later revealed moderate lower abdominal tenderness and rigidity most marked on the right side. There was no diminution of liver dulness. Patient was treated conservatively with a temporary amelioration of signs and symptoms, but the next day his condition became much worse, obviously due to a generalized peritonitis. Laparotomy revealed diffuse peritonitis secondary to a perforation on the antimesenteric border of a loop of small bowel 275 cm. above the ileocecal junction. The borders of the perforation were clean cut with prolapse of the mucous membrane, and exhibited no signs of underlying ulceration. The distended loops of bowel were emptied through an enlargement of the existing enterotomy which was then closed with Lembert sutures. Peritoneal drains were inserted and the wound closed. Exitus three days after operation. Necropsy revealed no ulcerative disease of the gastro-intestinal tract.

Case 12.—Campbell:[36] A 48 year old man, who had worn a truss for several weeks for a right inguinal hernia, experienced sudden sharp abdominal pain on attempting to lift a 200 pound bale shortly after a moderate meal. Four hours later he was operated upon for a rupture of the intestine. The hernial sac contained no viscera. There was a diffuse peritonitis secondary to a perforation of the midileum situated in the region of

* This case was reported from the Basel Surgical Clinic of Professor Hildebrand, where it was admitted in 1899. There is a strong likelihood that it is identical with Socin's case, which is also from that clinic, although several discrepancies are noted in the histories.

the right internal inguinal ring. The margins of the perforation exhibited mucosal prolapse. Following closure of the perforation the patient made an uneventful recovery.

Case 13.—Schwarz:[87] A 73 year old miner with a left inguinal hernia and a right hydrocele of 12 years' duration experienced severe pain in the left groin while lifting a ladder. He was admitted to the hospital the next morning with moderate abdominal distention and marked rigidity. Left inguinal herniotomy was performed 30 hours after the accident. When the sac was opened there was an efflux of turbid fluid and gas. A pea sized perforation with sharp margins was found on the antimesenteric border of the first loop of small bowel delivered into the wound. The perforation was sutured, the bowel replaced and the wound tamponaded. Exitus seven days after operation. Necropsy: Suture of perforation intact. Fibrinous peritonitis of the upper loops of bowel. Gangrene of descending colon due to thrombosis of the inferior mesenteric vein.

Case 14.—Bunge I:[7] A 48 year old man, who had had an intestinal ailment two years previously, was seized with severe right lower abdominal pain while supporting a heavy iron plate weighing several hundred pounds. Shortly afterward he was unable to resume his work because of pain and vomiting, for which he was hospitalized the next day. Physical examination revealed marked abdominal distention and boardlike rigidity. There was an egg sized tender reducible swelling in the right inguinal canal. A smaller similar hernia was present on the left side. Laparotomy revealed diffuse peritonitis secondary to a lentil sized perforation on the antimesenteric border of a loop of small bowel situated adjacent to the right internal inguinal ring. Surrounding the perforation there was an area of subserosal ecchymosis about 1 cm. in diameter, corresponding in size with that of the right internal inguinal ring. The margins of the perforation were clean cut with mucosal prolapse. The perforation was closed, the peritoneal exudate sponged up, and the abdominal wound closed with drainage. Following a prolonged convalescence the patient recovered.

Case 15.—Bunge III:[7] A 49 year old man, previously well except for well controlled bilateral inguinal herniae, experienced severe abdominal pain while lifting a heavy weight. The pain subsided in a short while and the patient was well again, continuing his work until about 36 hours later when the pain recurred, this time accompanied by vomiting which later became fecaloid. On admission to the hospital he presented diffuse abdominal tenderness and rigidity. Both inguinal canals were clear but tender. Immediate laparotomy (54 hours after the accident) revealed diffuse purulent peritonitis secondary to a pea sized perforation on the antimesenteric border of a loop of ileum 125 cm. above the ileocecal valve. The perforated loop was situated in the immediate vicinity of the right internal inguinal ring. The perforation was surrounded by an area of infarcted bowel about 1½ cm. in diameter. The perforation was sutured. Exitus occurred ten hours after operation. Necropsy: Diffuse peritonitis with right subphrenic abscess.

Case 16.—Talke:[88] A 53 year old laborer who had had a left inguinal hernia for 20 years suddenly experienced severe lower abdominal pain and protrusion of the hernia while carrying a heavy log. On admission to the hospital two hours later, he was found to have a somewhat tender easily reducible left inguinal hernia and tenderness in the left inguinal canal. He was observed for a period of 24 hours during which time there was an apparent amelioration of symptoms followed by a sudden adverse change in his condition and the appearance of frank signs of peritonitis. With the increasing distention, the hernia, which had previously been reducible, became tense and irreducible. Herniolaparotomy revealed a diffuse peritonitis secondary to a 1½ cm. irregular perforation on the antimesenteric border of the ileum 140 cm. above the ileocecal junction. The involved loop was situated 1 cm. from the left internal inguinal ring. There was prolapse of the mucous membrane. Following peritoneal lavage and *vorlagerung* of the affected portion of bowel, the operation was concluded. Exitus 12 hours after operation. Necropsy: Findings as at operation. No additional lesions of the gastro-intestinal tract. The mesentery of the involved loop of bowel exhibited two whitish, stellate, almond sized

scars such as are frequently seen in cases of long standing hernia as a reaction to previous habitual residence of the loop of bowel in the hernial sac.

Case 17.—Kempf:[39] A 55 year old man who had had a well controlled right inguinal hernia for many years was loading 175 pound sacks of cement on a wagon. He accomplished this by standing on one spot and transferring the sacks with a twisting motion of his body. After having loaded 70 such sacks he attempted to ease the burden of the last one by supporting it simultaneously with his right knee. At that moment he felt severe pain in the region of his hernia, vomited, and collapsed. On admission to the hospital shortly thereafter he presented moderate abdominal rigidity and a tender cylindrical irreducible swelling adjacent to the left spermatic cord and extending up into the inguinal canal. The mass felt like a hernial sac, but no statement could be made as to its contents. Herniotomy (six and one-half hours after the accident) revealed a quantity of free peritoneal fluid within the sac, obviously due to a diffuse peritonitis. The original incision was closed and laparotomy performed through a midline suprapubic incision. A lentil sized perforation, with everted mucous membrane, was found on the antimesenteric border of the ileum 70 cm. above the ileocecal valve. The perforation was closed and the peritoneal cavity drained. Exitus five days after operation. The postmortem examination revealed no additional significant findings.

Case 18.—Grasmann:[40] A 48 year old laborer who had had well controlled bilateral inguinal herniae of many years' duration experienced severe right lower abdominal pain while lifting a 100 pound weight in a half bent position. The pain soon subsided but required admission to the hospital three hours later. There he presented moderate abdominal rigidity and tenderness on deep palpation in the right lower quadrant. There was no obliteration of liver dulness. The left inguinal canal was empty. On the right side there was a movable mass about the size of a pigeon's egg, which did not fully disappear on pressure. There was tenderness in the right inguinal canal. Consent for immediate operation was withheld and there was apparent improvement in the symptomatology. The next morning, however, the pain, distention, rigidity, and tenderness became more marked and right herniolaparotomy was performed (17 hours after accident). The hernial sac and general peritoneal cavity contained free peritoneal fluid. Immediately adjacent to the internal inguinal ring there was a loop of lower ileum with a pea sized perforation on its antimesenteric border. There was prolapse of the mucous membrane, and a small subserosal hemorrhage at one point of the circumference of the perforation. The involved loop of bowel was brought out on the abdominal wall and the peritoneal cavity drained. Exitus 12 hours after operation. Necropsy: The mesenteric vessels were normal. There was no ulceration in the entire gastro-intestinal tract. Microscopic examination of the site of perforation revealed no pathology of note other than a slight small cell infiltration.

Case 19.—Köhler:[15] A 25 year old man, while lifting a half barrel of beer, felt a hernial mass protrude and simultaneously experienced severe abdominal pain. He was unable to continue his work, and on admission to the hospital complained of slight nausea followed that evening by vomiting. The abdomen was moderately tense with tenderness in the right lower quadrant. There was a thickening of the right hernial sac, but the contents of the hernia were readily reducible. The patient was observed for a day but because of continued symptoms was operated upon about 30 hours after the accident. A perforated loop of small bowel was found and resected. Exitus one day after operation. Examination of the excised specimen revealed the bowel wall surrounding the point of rupture to be normal. The postmortem examination showed no pathology of the remaining gastro-intestinal tract. At the hearing for compensation it was the opinion of the medical experts that perforation of the normal bowel wall could not occur without direct trauma. The case was therefore considered noncompensable although subsequent experience has not supported this conclusion.

Case 20.—Tchistosserdorff III:[41] A 44 year old butcher experienced pain and incarceration of an inguinal hernia on lifting a heavy barrel. Physical examination revealed

abdominal tenderness and rigidity. Laparotomy performed more than 24 hours after the accident revealed a 1½ cm. rupture of the small intestine, which was sutured. Exitus. Necropsy: General peritonitis.

Case 21.—Tchistosserdorff XXXVII:[41] A 27 year old laborer experienced pain and vomiting on lifting a 250 kilogram weight. Physical examination revealed diffuse abdominal tenderness and rigidity with an incarcerated hernia. Laparotomy performed 48 hours after the accident revealed a rupture of the jejunum which was sutured. Exitus. Necropsy: Diffuse peritonitis.

Case 22.—Conte:[42] A 47 year old man with a long standing well controlled right inguinal hernia experienced severe abdominal pain when, on making a misstep, he fixed his body in order to regain his equilibrium. He collapsed and was brought directly to the hospital where he presented abdominal tenderness and rigidity. He was observed for a period of 24 hours, when laparotomy was finally performed because of increasing abdominal distention, vomiting, and a rise in pulse rate. There was found a diffuse peritonitis secondary to a 3 cm. oval perforation on the antimesenteric border of the small intestine. The serosa was more extensively lacerated than the mucosa. The intestine was otherwise normal. Closure of the perforation was followed by recovery.

Case 23.—Quarella:[43] A 47 year old laborer who had had a right inguinal hernioplasty and who controlled a left inguinal hernia by a truss for the past five months, experienced severe pain in the left groin while lifting a box weighing about 11 kilograms. After a short interval he was able to walk home and vomited several times. Six hours later, on admission to the hospital, he presented diffuse abdominal rigidity and tenderness most marked in the left lower quadrant. There was no obliteration of liver dulness. The left inguinal hernia was completely reducible but the inguinal canal on that side was quite tender. Herniotomy was performed but the sac was found to contain only purulent fluid with a fecal odor. The abdomen was then opened and an oval perforation about ½ cm. in diameter was found on the antimesenteric border of a loop of small bowel. The margins of the perforation were clean cut with mucosal prolapse and with no evidence of contusion. The perforation was sutured and the peritoneal cavity drained. Recovery.

Case 24.—Jennings I:[44] An adult male, previously well, experienced stabbing pain in the abdomen while lifting a 90 pound barrel. He was unable to continue work but walked home, where he soon vomited. On admission to the hospital three hours later, he presented diffuse abdominal rigidity. Immediate laparotomy revealed a diffuse peritonitis secondary to an ileal perforation two feet above the ileocecal valve. No other perforations were found. The point of rupture was sutured and the peritoneal cavity drained. Postoperative course complicated by a wound dehiscence for which a secondary suture was necessary. This was followed by bronchopneumonia and exitus on the fourteenth day after operation.

Case 25.—Jennings II:[44] A 46 year old longshoreman had been operated upon for bilateral inguinal herniae 13 years ago and again 11 years ago for a recurrent right inguinal hernia. Shortly thereafter he made a sudden violent effort to prevent a barrel from rolling off a deck. As he did so he experienced abdominal pain and collapsed. He was promptly operated upon for ruptured intestine. Two years later, while helping to "jack" a timber weighing 400 pounds he had a similar experience and was again operated upon for rupture of the bowel. He came under the care of the reporter for a third intestinal rupture, this time, however, due to a direct abdominal injury. During this operation a cicatrix of one of the old perforations was found three and one-half feet proximal to the ileocecal junction. The patient made an uneventful recovery.

Case 26.—Finkelnburg I:[45] A 48 year old man with bilateral inguinal herniae experienced severe abdominal pain while pulling a ladle out of a furnace. Laparotomy performed that evening revealed a diffuse purulent peritonitis secondary to a perforation of the small bowel. Exitus one day after operation.

Case 27.—Finkelnburg II:[45] A 53 year old man with bilateral inguinal herniae experienced severe abdominal pain while attempting to empty a tub of water weighing

about 74 pounds. Laparotomy performed that evening revealed a diffuse purulent peritonitis secondary to a 3 cm. perforation of a loop of small intestine in the region of the right internal inguinal ring. Exitus two days after operation. Necropsy: Suture intact. Pneumonia right lower lobe.

Case 28.—Gangl:[46] A truckman who had previously had a successful right inguinal hernioplasty and who had had a left inguinal hernia for the past ten years experienced severe left lower abdominal pain while lifting a keg of beer. This was followed several hours later by nausea. On admission to the hospital that afternoon he exhibited diffuse abdominal tenderness and rigidity, especially in the lower quadrants. Rectal examination revealed a swelling in the rectovesical pouch. There was tenderness in the left inguinal canal. Herniolaparotomy (eight hours after accident) revealed purulent fluid in the hernial sac and general peritoneal cavity. A 1 cm. transverse laceration with mucosal prolapse was found on the antimesenteric border of a loop of midileum. There were several old adhesions proximal and distal to the site of perforation, indicating that this loop had frequently descended into the hernial sac previously. Following enterorrhaphy and peritoneal drainage the patient made an uneventful recovery.

Case 29.—Ollonqvist:[47] A 20 year old soldier experienced marked abdominal pain during a wrestling match after a heavy meal. No herniae. At operation a pea sized perforation was found in the small intestine.

Case 30.—Taylor II:[11] A 57 year old fruit grower, while trying to lift a draw-bolt weighing about one hundredweight, experienced severe lower abdominal pain followed by nausea and vomiting. He had had an intestinal ailment 27 years previously for a period of one week and had been sick with vomiting one week before the present illness. On admission to the hospital several hours after the accident, he presented abdominal distention, rigidity, tenderness, and rebound tenderness, most marked below the umbilicus. There were bilateral inguinal herniae. Laparotomy revealed a five-eighths inch longitudinal tear near the antimesenteric border of the small intestine about three meters below the duodenojejunal flexure. Following enterorrhaphy and peritoneal drainage the patient made an uneventful recovery. He died four months later, apparently of tuberculosis bronchopneumonia. There were no symptoms of tuberculous enteritis.

Case 31.—Taylor III:[11] A 64 year old man, suffering from prostatic hypertrophy, experienced sudden severe lower abdominal pain and vomiting while straining at micturition. On admission to the hospital 16 hours later he presented diffuse board-like abdominal rigidity and tenderness, most marked below the umbilicus. There was a small left irreducible hernia. Laparotomy revealed a diffuse fecal peritonitis secondary to a one-half inch tear on the antimesenteric border of the small intestine at about its center. There were mucosal prolapse and engorgement of the surrounding tissue for one-fourth of an inch. Following enterorrhaphy and drainage the patient recovered.

Case 32.—Deton and Belot:[16] An Italian laborer, while pulling up a rail, experienced abdominal pain for which he was sent to the hospital. Physical examination revealed abdominal rigidity and tenderness most marked in the right iliac fossa. There was a nontender right inguinal hernia. Laparotomy performed ten hours after the accident revealed a diffuse peritonitis secondary to a 3 cm. perforation on the antimesenteric border of a loop of small bowel. There was eversion of the mucous membrane but no other change in the bowel wall. The bowel above and below the lesion was explored for a distance of 40 cm. Peyer's patches were not seen. Following enterorrhaphy, appendicectomy, and peritoneal toilet the patient made an uneventful recovery.

Case 33.—Siegmund:[48] A 41 year old laborer, while lifting a heavy sack of grain, suddenly experienced such severe abdominal pain radiating to the left testis that he collapsed. This was followed by complete obstipation and continuous vomiting. He had had a left inguinal hernia for many years. Twenty-four hours later, on admission to the hospital, he presented abdominal distention and board-like rigidity throughout. There was diminution of liver dulness. There was a small easily reducible left inguinal hernia. Laparotomy revealed a diffuse peritonitis secondary to a 1½ cm. transverse oval perfora-

abdominal tenderness and rigidity. Laparotomy performed more than 24 hours after the accident revealed a 1½ cm. rupture of the small intestine, which was sutured. Exitus. Necropsy: General peritonitis.

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about 74 pounds. Laparotomy performed that evening revealed a diffuse purulent peritonitis secondary to a 3 cm. perforation of a loop of small intestine in the region of the right internal inguinal ring. Exitus two days after operation. Necropsy: Suture intact. Pneumonia right lower lobe.

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tion on the antimesenteric border of a loop of small bowel in the region of the left internal inguinal ring. About ½ cm. away there was a second perforation about ½ cm. in diameter. The edges of the perforations showed mucosal prolapse but no other pathology. Enterorrhaphy and peritoneal drainage effected. Exitus ten hours after operation. There were no demonstrable additional findings at the postmortem examination.

Case 34.—Wiedhopf:[17] A 45 year old man, while lifting an iron weight of 60 or 80 pounds, experienced abdominal pain which subsided after a time. Eight hours later, while attempting to lift a bundle of brush wood weighing 40 or 50 pounds, he again experienced abdominal pain, vomiting and complete collapse. An inguinal hernia was noted on physical examination. An acute perforation of a gastric ulcer was suspected. Eight hours later laparotomy was performed and a diffuse peritonitis secondary to a 1½ cm. longitudinal oval perforation on the antimesenteric border of the ileum was found. There was no evidence of underlying ulceration. Following enterorrhaphy the patient made an uneventful recovery. Compensation granted.

Case 35.—Breuning:[50] The patient, who had had a right inguinal hernia for many years, experienced severe right lower abdominal pain and collapsed while setting down a case of food which he had been carrying. The next morning he presented marked abdominal tenderness, distention and diffuse board-like rigidity, most marked in the right lower quadrant. An empty right inguinal hernial sac was present. Immediate laparotomy revealed a diffuse peritonitis secondary to a penny sized perforation on the antimesenteric border of a loop of terminal ileum. There was no evidence of underlying ulceration. Enterorrhaphy and peritoneal drainage. Exitus four days after operation. Necropsy: There was macroscopic swelling of Peyer's patches for a considerable distance above and below the site of perforation, but these, on careful histologic examination, revealed no evidence of typhoid or tuberculosis.

Case 36.—Lunckenhein:[51] A 59 year old railroad worker, while walking on an embankment, tripped and was about to fall forward when he pulled himself back by a sudden muscular effort. He immediately experienced a sticking pain in the abdomen followed shortly thereafter by vomiting. Physical examination 11 hours later revealed board-like abdominal rigidity and general symptoms of peritonitis. Immediate laparotomy revealed a diffuse peritonitis secondary to a perforation of the jejunum about 3 cm. long. Following an enterorrhaphy and peritoneal drainage the patient made an uneventful recovery.

Case 37.—Breitkopf:[52] A middle aged man with a left inguinal hernia experienced sudden lower abdominal pain while lifting a heavy chest. This was followed by meteorism and signs of peritonitis, for which laparotomy was performed. A round perforation of a loop of midileum adherent to the sigmoid was found. This loop of ileum was resected, which, on histologic examination, revealed no evidence of any specific ulcerative process.

Case 38.—Hahn:[53] A 37 year old laborer with bilateral small inguinal herniae experienced severe lower abdominal pain while straining at stool. Four hours later physical examination revealed signs of diffuse peritonitis. There was questionable diminution of liver dulness. Laparotomy revealed a diffuse fecal peritonitis secondary to a 2 cm. longitudinal tear on the antimesenteric border of the sigmoid about one handbreadth above the peritoneal reflection of the rectovesical pouch. The intestinal wall exhibited no other changes, and normal mucosa was seen prolapsing through the perforation. No evidence of diverticulosis. After peritoneal toilet the sigmoidal perforation was sutured to the abdominal wall to form a temporary fecal fistula. Uneventful recovery.

Case 39.—Hilgenfeldt I:[54] A 49 year old man who had had a bilateral inguinal hernioplasty two years previously and a left recurrent inguinal hernioplasty shortly thereafter experienced severe left lower abdominal pain radiating to the testicle while lifting a heavy iron ring. Eight hours later physical examination revealed moderate abdominal rigidity and marked tenderness of the left inguinal canal, where a walnut sized hernia could be felt when the patient coughed. Liver dulness was diminished. Laparotomy revealed free gas in the peritoneal cavity and a diffuse peritonitis secondary to a 1½ cm.

longitudinal oval perforation on the antimesenteric border of the lower ileum. The borders of the perforation were sharp and showed no other changes. Following intestinal suture and peritoneal irrigation the patient died four days later. No additional findings were demonstrated at autopsy.

Case 40.—Hilgenfeldt II:[54] A 47 year old laborer, while pushing a wagon, experienced severe pain in the right groin and was promptly operated upon for a supposed incarcerated right inguinal hernia. At operation, however, the sac was found to contain only fecal fluid, which was also present in the general peritoneal cavity. A 2 cm. longitudinal perforation of the small intestine was found and sutured. Peritoneal cavity irrigated. Exitus one day after operation. Necropsy: No additional findings.

Case 41.—Vance:[49] A 59 year old man, while lifting a barrel of apples, was seized with sudden knife-like abdominal pain. On admission to the hospital, he presented diffuse abdominal tenderness and rigidity. Laparotomy revealed a 1 cm. perforation of the small intestine, which was sutured. Enterostomy was performed with a catheter 15 cm. proximal to the perforation. Uneventful recovery.

Case 42.—Røvig:[55] A 69 year old man with a right inguinal hernia of two years' duration experienced severe right lower abdominal pain on lifting his right leg in an attempt to jump over a fence. He collapsed and had to be carried home, where the pain continued and was accompanied by vomiting. Physical examination seven hours later revealed diffuse abdominal tenderness and board-like rigidity, especially on the right side. There was a walnut sized right reducible hernia. Roentgenologic examination of the abdomen in sitting position showed free gas under the right leaf of the diaphragm. At operation the hernial sac was found to be thickened and contained only foul black fluid, which was also present in the general peritoneal cavity. A small perforation was seen on the antimesenteric border of a loop of ileum. This was closed and peritoneal drainage effected. Uneventful recovery.

Etiology.—At the time Bunge first called attention to the relationship of hernia to intestinal rupture he was able to support his theory by only two personal cases and the case reports of Socin[32] and Mikulicz.[30] Since then a total of 43 cases, including the one cited in this communication, have been reported. If Bunge's hypothesis is correct, these cases should show a high incidence of hernia. Exact figures cannot be ascertained due to the inadequacy of some of the reports, especially when the presence or absence of hernia was not considered relevant by some of the writers. In only two cases (Cases 7 and 29) was it stated that no hernia was present, while in 33 cases a hernia was definitely mentioned. Of the remaining eight cases, in which no statement is made either way, five were reported before the publication of Bunge's paper and the other three were reported by other authors[44, 49, 51] who made no reference to Bunge's theory and who apparently were not familiar with his work. It is quite possible that although herniae may have been present in these eight cases, they were considered irrelevant and not mentioned in the brief case reports. It may also be pointed out here that the weakness in the abdominal parietes requisite for intestinal rupture may be represented by an internal hernia or perhaps only a potential one at a hiatus of entrance or exit of an abdominal organ or vessel which escaped the notice of the observer.

Interesting clinical evidence in support of the assumption of the abdominal wall weakness as a factor in the production of bursting rupture of bowel is brought forward by Borszéky,[56] who reported three cases in which direct

trauma to remote portions of the anterior abdominal wall was followed by bursting rupture of the small intestine in the immediate vicinity of the internal inguinal rings of herniae, which were present in all three cases. He suggested that even if the direct trauma is not of sufficient force to produce a crushing rupture of the loop of bowel it encounters, it may still stimulate a reflex contraction of the abdominal musculature of a magnitude sufficient to provoke a bursting rupture of a distant loop of bowel in susceptible subjects (*i.e.*, ones in whom there is a weakness of the abdominal parietes, external or internal).

The degree of pressure necessary to produce rupture of the bowel is not very large, as has been shown by Burt[57] and Andrews,[58] both of whom were able to produce rupture of the ileum in an excised segment of bowel by one-half of an atmospheric pressure gradually applied and even less when applied suddenly. It has not been demonstrated whether the same pressure is required in living human intestine but this is presumably the case, for Hertle[59] has demonstrated in animal experiments that the distensibility of freshly excised bowel is the same as that of a segment of bowel in vivo.

Clinical Features.—*Sex.*—All patients in the series were male. This is probably explained by the fact that men are more active in those pursuits which necessitate excessive abdominal straining.

Age.—Ages varied from 21 to 73, the average being 48. More than two-thirds of all cases were in patients in the fifth and sixth decades of life. This distribution parallels the usual maximum of muscular activity in industry.

Hernia.—The high incidence of hernia in the series has been commented upon in the section on etiology. It may be present on either side, or may be bilateral. All were of the inguinal variety, although this is not surprising in view of the fact that all the patients were male, in which sex inguinal herniae usually outnumber femoral hernia by 20 to 1. The duration of the hernia does not appear to be of great moment. In some cases it had been noted by the patient for years; in others it was first found on physical examination. Most of the herniae were not large and many were quite small. This is in harmony with our view of the pathogenesis of the intestinal rupture, for if the sac were large and had a wide internal ring, an entire loop of bowel would be pressed into the sac during the moment of increased abdominal pressure instead of just one of its walls, and there would be no *locus minoris resistentiae* of the intestinal wall. In several cases a previous hernioplasty had been effected but even the slight peritoneal dimpling produced by a minor recurrence of the hernia is sufficient to form the vulnerable point in the abdominal wall as in Hilgenfeldt's first case (Case 39). This may have been the condition in Jennings' second case (Case 25), but the patient recovered and confirmation was impossible.

The use of a truss is apparently not sufficient to prevent intestinal rupture in hernia. Trusses were worn in 11 of the cases, although in only three reports was it definitely stated that the truss was worn at the time of the accident (Cases 9, 17 and 18). Although these appliances may be sufficient

to prevent the hernia from coming out during ordinary activity, their resiliency may be overcome by the sudden increase in intra-abdominal pressure during muscular effort. In Thommen's case,[33] the patient actually observed that the hernia came out under the truss during the effort and then became reduced. In Kempf's case,[39] the patient had been unloading sacks of cement by a twisting motion of his body. He had lifted 70 sacks by the same maneuver but on lifting the last one he supported it with his right knee and in so doing he may have displaced the truss which he had been wearing for a right inguinal hernia. It was at this point that he experienced the sudden onset of pain so characteristic of bowel rupture.

Previous Intestinal Ailments were noted in only four cases and even in these the preëxisting affection did not appear to have any likely bearing upon the present illness. While intestinal ulceration must necessarily predispose to bowel rupture, we have been careful to exclude such lesions from the series of cases under discussion.

Nature of Precipitating Accident.—The one factor common to all the stimuli was that they evoked a response of sudden contraction of the abdominal musculature. These may be listed as follows:

NATURE OF PRECIPITATING ACCIDENT

Lifting a heavy weight	28
Pulling against resistance	5
Sudden effort to regain equilibrium after misstep or low jump	6
Straining during defecation	2
Straining during micturition	1
Wrestling	1

The relationship of the time of the accident to the immediately preceding meal is an important one in view of the fact that a distended intestine is more likely to rupture than a collapsed one. Of the 23 cases in which the time of the accident was noted, it was definitely stated in five that the precipitating effort occurred shortly after a meal. In nine cases it is highly probable that the times mentioned were shortly after breakfast or lunch. Most of the remaining cases also occurred at times when there was probably a good deal of digestive activity.

PATHOLOGY.—It is a significant observation that in no case was a retroperitoneal loop of bowel (duodenum or colon) ruptured. Where noted, all perforations occurred at or near the antimesenteric border of the involved loop of bowel, which, in all cases, was applied with mesenteric attachments sufficiently mobile to permit apposition of the bowel wall to the internal ring. It can readily be visualized that the antimesenteric border of the bowel would be the one which would come up against the internal ring and it is this explanation which is given to account for the universal occurrence of the rupture on the convexity of the intestinal segment. Of the two cases in which the large bowel was involved (Cases 1 and 38) it is interesting to note that the rupture of the cecum was associated with a right inguinal hernia and the rupture of the sigmoid with a left inguinal hernia.

The level of small intestine involved varied, but the ileum was the most frequently affected portion. In those cases where the distance in centimeters from the ileocecal valve was measured it was revealed that in all cases where that distance was found to be less than 140 cm. the perforation was associated with a right inguinal hernia. This could be interpreted to mean that the loops of terminal ileum, being located mainly in the right iliac fossa, could not easily be apposed to the left internal inguinal ring and that ruptures associated with herniae on the left side occur in more proximal portions of ileum and jejunum which can more readily reach either internal ring. In several cases the perforated loop of bowel was found at operation to lie in the immediate vicinity of the ring.

All the perforations were single except in Siegmund's case (Case 33) where the two points of rupture were separated by only 5 cm. This is in marked contrast with the incidence of multiple distant perforations in other series of subparietal intestinal rupture produced by direct trauma. Berry and Giuseppi[60] reported 22 multiple ruptures in 132 cases, and Hertle[59] found a similar incidence of 20 multiple ruptures in 128 cases of intestinal rupture produced by direct trauma. This fact then also indicates the essential difference in the mechanism by which the ruptures were produced, and, if we accept the explanation of a blowout at the internal ring of a hernia, we can readily see that ruptures produced by this mechanism must necessarily be single. This point is of therapeutic importance for it permits of a technical application in operating for intestinal rupture without external violence. In these cases one is justified in closing the perforation and concluding the operation without further exploration, while in those associated with direct trauma to the abdomen the high incidence of multiple perforations makes it necessary to explore the entire gastro-intestinal tract before closing the abdominal wounds.

The perforations are usually round or oval in shape with their long axis parallel to that of the bowel. This shape is explained by Hertle[59] as due to unequal degrees of laceration of the different layers of the intestinal wall. He concluded on the basis of experimental work that distention of bowel produced rupture first of the serosa, then the mucosa, and finally the submucosa, which, because of its network of elastic fibers, has the greatest tensile strength. Retraction of the longitudinal muscle is greater than that of the circular so that the rupture usually assumes an oval shape.

The size of the perforations in this series varied from that of a lentil to that of a penny. The mucosa was everted in more than two-thirds of the 20 cases in which the condition of the mucosa was noted. This herniation of the mucous membrane was first pointed out by Moty[2] as characteristic of bursting ruptures. He rightly observed that the mucosal prolapse, instead of occluding the perforation, forms a canal which is not likely to close and which is quite probably responsible for the gravity of this lesion.

The borders of the rupture were generally noted to be sharp and clean. In only two cases (Cases 9 and 31) was any thickening or induration of

the bowel wall surrounding the perforation described. Whether this represents a previous lesion which perforated or a secondary change following the perforation is a matter of conjecture, but we are inclined toward the latter opinion in view of the fact that in these two as in all the remaining cases no other pathology was demonstrable in the remainder of the gastrointestinal tract.

The mesentery showed few changes. In Cases 8 and 16 the mesentery of the bowel opposite the point of perforation exhibited whitish stellate scars which probably represent peritoneal reaction to previous habitual entrance of that loop into the hernial sac. In Mikulicz's case[30] there were numerous mesenteric nodes enlarged to the size of hazel nuts; their etiology remains obscure but it is not unlikely that they were secondary to the marked generalized peritonitis which was of relatively long standing (72 hours) in this case. In Campbell's case[36] there was a transverse tear in the mesentery opposite the point of perforation at the antimesenteric border. This may have been produced by traction. When the antimesenteric border was evaginated into the hernial sac, the mesenteric border naturally tended to follow, and, with insufficient length of mesentery, produced a tear.

The peritonitis which was present in every case was of the usual fibrinopurulent type secondary to intestinal perforation. Attempts at localization were very slight due to the continual outpouring of intestinal contents. Gas in the free peritoneal cavity was noted at operation by several observers. The wall of the hernial sac as well as the remainder of the entire peritoneum was thickened and covered with fibrinous exudate according to many of the reports. In cases where the hernial sac was opened first, only peritoneal exudate was found, except in Scarpa's case[25] where the ruptured cecum had remained in the sac due to the coincidental incarceration of a prolapsed loop of ileum in the same hernia.

SYMPTOMATOLOGY.—There is a remarkable similarity in the histories reported by 37 different observers. The patient, usually in excellent health except for a well controlled reducible hernia, usually engaged in a strenuous effort, often shortly after a meal. In all cases there was a sudden onset of very severe lower abdominal pain, characteristically described by the patient as "bursting." The initial pain is often felt on the side of the hernia, but it soon becomes generalized. The sudden onset is usually associated with shock so that the patient frequently falls to the ground. Nausea and vomiting supervene promptly and at times are of a magnitude sufficient to make the observer suspect intestinal obstruction. Following the primary shock there is often an amelioration of symptoms permitting the patient to walk home or to the hospital. It is usually during this interval that he is first seen by the physician. At this time he usually complains of moderate abdominal pain. Temperature and pulse are almost universally normal. There are, generally, moderate abdominal tenderness and rigidity which scarcely tend to indicate the underlying intraperitoneal catastrophe. The hernia is usually easily reducible at this time although later (as in Talke's

case) it may become irreducible due to the intestinal distention. A significant, but not commonly observed finding, is tenderness in the inguinal canal on the involved side. Gangl[46] was able to detect a swelling in the rectovesical pouch on rectal examination. Diminution of liver dulness has been noted by three observers, but the best method of demonstrating gas in the free peritoneal cavity is by a roentenogram of the abdomen with the patient sitting up and without the use of any contrast media. This was done in only one case (Case 42) and established with certainty the diagnosis of perforation of the gastro-intestinal tract.

If not operated upon at this stage, the patient does seemingly well for about another 24 to 36 hours, when the signs of generalized peritonitis become obvious. There is a sudden, sometimes dramatic change in the patient's general appearance. The facies become anxious, the tongue dry. The pulse becomes weak and rapid, the abdomen distended, tender and rigid. Vomiting reappears and is usually accompanied by obstipation due to paralytic ileus, although at times a perisigmoidal peritonitic process may be associated with diarrhea. The diagnosis of generalized peritonitis presents no difficulties at this stage, but the prognosis has now become extremely grave, death usually occurring regardless of any operative intervention.

One is struck by the similarity of the period of masked peritonitis following recovery from the initial shock with the more familiar period of latent peritoneal reaction following perforation of a gastric or duodenal ulcer. It is during this stage that the diagnosis must be made and operation performed if any appreciable number of these cases is to be saved.

Diagnosis is made on the basis of the characteristic history of sudden severe "bursting" pain during or immediately following a sudden extraordinary effort by a patient with a hernia. Abdominal tenderness and rigidity with tenderness in the inguinal canal are suggestive. Demonstration of gas in the free peritoneal cavity by clinical and roentgenologic methods is conclusive. Diagnostic peritoneal puncture for the purpose of demonstrating the presence of purulent exudate has not been tried in any of the reported cases, and is suggested in selected cases, but ordinarily there should be abundant evidence of the essential nature of the lesion (perforation, peritonitis) so that the indication for immediate operation should be made early.

Differential Diagnosis.—The correct preoperative diagnosis has been made only once (Røvig). Other surgeons have operated for incarcerated hernia, internal incarcerated hernia, appendicitis, perityphlitis, perforated gastric ulcer, "complication of hernia," and peritonitis of uncertain origin.

The diagnosis of incarcerated hernia is often made for want of a better one. It is suggested by the tender swelling of the sac produced by the peritoneal exudate. It should be ruled out by the fact that the hernia can be completely reduced. Reduction en masse of an incarcerated hernia or internal incarceration is not as easily ruled out, but is usually accompanied by symptoms of intestinal obstruction rather than by those of peritonitis.

Appendicitis is rarely so sudden in its onset and is not as likely to present

signs of diffuse peritoneal irritation as early as is intestinal rupture. The course is usually not as fulminating and there is usually a greater tendency to localization of a peri-appendiceal abscess.

Perforated peptic ulcer is more apt to be accompanied by tenderness and rigidity in the upper quadrants than is intestinal perforation. With care a history of even a short period of preceding dyspepsia can usually be elicited. If a hernia is present in a patient with a perforated peptic ulcer, it is not likely to be as tender as in cases of intestinal rupture, where the intestinal contents are forced into the sac at the time of rupture.

Perforated typhoid, tuberculous and nonspecific ulcers of the intestine should be suspected on the basis of previous intestinal and general symptomatology, serologic studies and examination of the stool.

Spontaneous perforation of the stomach is an extremely rare accident which may be suggested by the history of extreme distention of the stomach following excessive eating or drinking. The symptoms are predominantly upper abdominal and resemble those of perforated peptic ulcer.

Spontaneous perforation of the rectum[61] is a condition related to that under consideration. Rupture usually takes place on the anterior surface of the rectosigmoid with prolapse of one or more loops of small bowel into the rectum; these may be felt on rectal examination. There is generally a history of preceding rectal prolapse which is in turn an expression of weakness of the pelvic floor. Women are predominately affected, and the accident almost always occurs during straining at stool. The weakness in the pelvic floor, augmented by the pathologic changes induced in the rectal wall by prolapse, is the *locus minoris resistentiae* of the abdominal parietes during straining.

Pneumatic rupture of intestine[57, 58] is a relatively new industrial accident noted since the introduction of the use of compressed air in construction work. Laborers are often "hazed" by their fellow workers who direct a stream of compressed air at the anus. The force of the air current is usually sufficient to separate the nates and allow the air to enter the sigmoid under pressure. Rupture generally occurs at this point and is followed by shock and a clinical picture closely resembling that which we have described. This condition is to be strongly suspected if the patient's occupation brings him in contact with compressed air even if the nature of the accident is denied at first.

Spontaneous rupture of the spleen almost always occurs in a pathologically enlarged spleen which may be indicated by the history or a previous physical examination. There may be a suggestive concomitant lymphadenopathy as in Hodgkin's disease or diagnostic changes in the blood as in leukemia or malaria. The shock is generally greater than in intestinal rupture and the general picture is more that of concealed hemorrhage than that of peritonitis.

Prognosis.—The prognosis is directly related to the promptness of surgical intervention. There is apparently little possibility for spontaneous cure, and no such experience has been reported. As may be noted in the appended

table, the best results are obtained in those cases operated upon within the first 12 hours.

OPERATIVE MORTALITY ACCORDING TO TIME INTERVAL BEFORE OPERATION

Time Interval Before Operation	Cases	Deaths	Percentage of Mortality
0 to 12 hours	15	6	40%
13 to 24 hours	7	5	71%
25 hours or later	13	11	84%
Unoperated	4	4	100%
Interval not stated* (presumably promptly)	2	0	0%
Outcome not stated	2		

* Cases 25 and 38.

Mortality has also been affected by the progressive development during the past three decades in diagnosis, surgical technic, methods of preoperative preparation, anesthesia, and postoperative care. While the exact effect of each individual factor cannot readily be estimated, we have found that the mortality in the first 21 recorded cases was 86 per cent, while that in the last 20 cases (since 1912) was 40 per cent.

There are no extensive follow up reports available, so that our knowledge of complications and sequelae is fragmentary. In only one case (Case 25) was there a recurrence of the same accident in the same patient. This patient survived both perforations, and, at a later date revealed no gastrointestinal pathology on a third laparotomy.

Treatment.—It is conceded by all writers that the treatment of choice is surgical intervention at the earliest possible moment even in cases where the diagnosis is only suspected. In almost all cases the perforation is readily closed without encroachment of the lumen of the bowel by two transverse layers of Lembert sutures. If much narrowing should occur, however, an enterostomy above the level of the enterorrhaphy may be performed, as in Vance's case (Case 34), or continuous suction drainage may be applied by duodenal intubation according to the method of Wangensteen[62] for several days after operation. If, as in Breitkopf's case,[52] the perforation is considered too large to permit of ordinary closure, a resection of the involved loop may be necessary. Occasionally the general condition of the patient may be so poor as to permit only a minimum of surgery, in which case a *vorlagerung* of the involved loop upon the abdominal wall may be the procedure of choice (Cases 16 and 18).

In view of the peritonitis which is always present, it is unwise to proceed with further exploration after the point of rupture has been found, for distant multiple ruptures have never been found in perforation due to muscular effort alone. Instead, attempts should be made to preserve asepsis and prevent dissemination of the infective material throughout the peritoneal cavity. Peritoneal exudate should be removed by suction as completely as possible,

and one or more drains placed in the pelvis or other intraperitoneal fossae according to the judgment of the surgeon. These may be brought out through the original wound or through counter incisions. Because of the almost inevitable wound contamination, provision should likewise be made for drainage of the abdominal wound according to general surgical principles. Postoperative measures should include intravenous infusions, transfusions, and other supportive measures of established merit.

Most of the explorations have been made through either hernioplasty or linea alba incisions. While the former allows of a more accurate exploration of the sac in cases where a complication of hernia is suspected, the later incision is the preferable one. It permits better exposure with access to both sides of the abdomen; it is more readily enlarged if necessary; and it permits of better drainage. Infection of a herniolaparotomy wound may render more difficult a subsequent hernioplasty, which in any case should be advised after recovery from the acute emergency. It is inadvisable to attempt hernioplasty at the primary operation due to the additional length of operating time which this procedure entails and to the unlikelihood of healing of the wound by primary union.

Compensability.—While we feel that the presence of a hernia is a strong predisposing factor to intestinal rupture by muscular effort, we believe that the rupture would not have taken place if the precipitating stimulus of effort had not occurred. If this effort is of an industrial character, the accident may then properly be considered a consequence thereof, and accordingly compensable. We are supported in this opinion by other writers on this subject.[15, 16, 17, 48, 50] In our own case compensation was also granted.

SUMMARY.—Attention is directed to the syndrome following intestinal rupture produced without external violence but by muscular effort alone.

Such a case is reported with a review of the literature.

Etiology and pathology are discussed and the important predisposing rôle of hernia and other weaknesses of the abdominal parietes emphasized.

Clinical features, methods of diagnosis, and operative procedures are described.

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REGIONAL ILEITIS AND FIBROPLASTIC APPENDICITIS*

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IN 1932, Crohn, Ginzburg and Oppenheimer[1] reported what they believed was a new clinical entity, a granulomatous lesion of the small bowel which they stated was constantly confined to the ileum. They gave to this the name regional ileitis. The picture which they described was so striking that it seemed hardly possible that clinicians could have overlooked it for so many years.

A review of the medical literature reëmphasizes what has been so wisely said: "that which is supposedly new in medicine may not be new, but merely rediscovery and elaboration," for it is probable that John Abercrombie of Edinburgh described a similar lesion in 1828. In 1907, Proust,[2] and in 1909, Braun[3] called attention to the occurrence of nonspecific inflammatory tumors of the intestine and since that time a great many similar reports have been recorded in surgical and pathologic literature.[4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 25]

It remained, however, for Crohn and his associates[1] to give us an original, detailed study of a number of cases under their observation, with an analysis of the history and course of the disease together with its pathologic anatomy. If it be true that isolated case reports do not constitute a classical description of a disease, then Crohn and his coworkers must be said to have given us a new clinical entity.

Four years ago the disease was thought by internists and surgeons to be a rare one, but in the intervening time it has come to be recognized with increasing frequency. A very interesting and thorough discussion of the lesion was given by Bockus and Lee[18] in 1935. Appended to this article is an excellent bibliography. Our own experience within the past few years has led us to believe that the lesion is frequently overlooked in its earlier stages and as frequently misdiagnosed in its terminal stages.

The nomenclature of the lesion has been varied, for the disease has been called regional ileitis, terminal ileitis, sclerosing enteritis, nonspecific inflammatory tumor, and nonspecific granuloma of the intestinal tract. The latter term seems to us to be the best, for it more accurately describes the cellular pathology of the lesion and we have come to know that the small bowel may not alone be involved.[19] Although the terminal ileum is most

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frequently the site of the lesion, no portion of the intestinal tract can be said to be immune to it.

No definite etiologic factors have been found. Infection by various organisms commonly found in the intestinal tract has been suggested. Some investigators believe that the lesion is caused by the same organisms associated with ulcerative colitis and bacillary dysentery. Erdmann and Burt[13] believe that certain toxins in the intestinal tract when in contact with a broken mucosa may precipitate the condition. This seems to us highly unlikely since the lesion has not been reported following resection of the in-

FIG. 1.—Resected terminal ileum, cecum and ascending colon.

FIG. 2.—Resected terminal ileum, cecum and ascending colon.

testine for other conditions. It seems possible that a virus infection may be the etiologic factor as suggested by Razzaboni.[20]

Many attempts to identify specific micro-organisms by aerobic and anaerobic methods of culture, by specific staining methods, and by animal inoculation have failed.

Bockus and Lee suggest that the lesion may follow an acute terminal ileitis and in at least one of our cases we have observed such a process. The lesion was examined at operation, but subsequent roentgenologic studies failed to disclose the characteristic findings of the disease.

In the early stage of the disease the involved intestine is reddened and thickened, the thickening being in part due to the accompanying edema. The

FIG. 4.—Photomicrograph of a specimen removed from a case of terminal ileitis (×112).

FIG. 3.—Photomicrograph of a specimen removed from a case of terminal ileitis (×112).

gross picture is not unlike that observed in acute typhlitis. The lesion is early associated with muscular hypertrophy and fibroblastic proliferation. In its later stages it involves all of the coats of the intestine and does not tend to be circumscribed. There occurs infiltration and edema of the intestinal wall, the mesentery and, after a time, the regional lymph nodes (Figs. 1 and 2). The ulceration which occurs would appear to be secondary to the changes in the mucosal and submucosal layers. The fibroblastic proliferation leads eventually to distortion and even occlusion of the lumen of the intestine (Figs. 3 and 4). The lymph nodes draining the involved area are, in the later stages of the disease, markedly enlarged and show a nonspecific inflam-

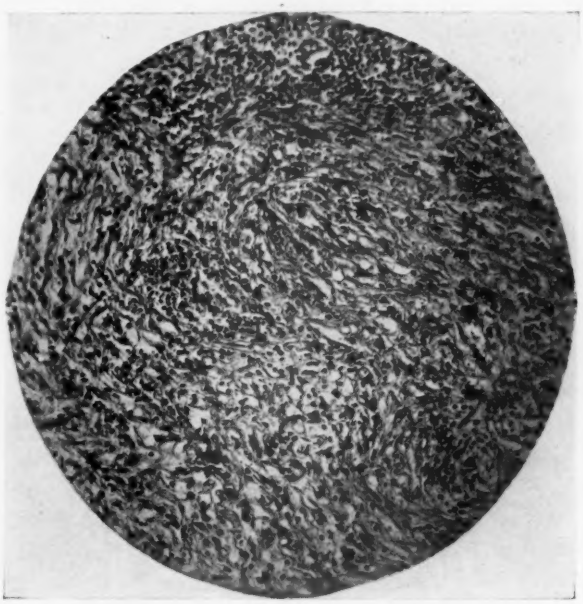

FIG. 5.—Photomicrograph from a case of fibroplastic appendicitis (×112).

matory reaction. Perforation and fistula formation may subsequently occur. Histologic sections frequently show the presence of giant cells, thus confusing the diagnosis of the condition at times with tuberculosis of the intestine. The pathologic picture as well as the clinical course of the disease may vary.

We have recently had two instances of fibroplastic appendicitis come to operation, and the histologic appearance of the lesion in this disease is so similar in many respects to that seen in the fibroplastic stage of regional ileitis as to warrant a comparison of the two lesions. In each instance all the coats of the appendix were thickened. The two most prominent features were generalized fibrous hyperplasia and infiltration with leukocytes. The mucous membrane was intact in many places but was broken in others. The submucous, muscular and serous layers were greatly thickened with a very marked fibroblastic proliferation (Fig. 5).

The similarity of the pathologic process in the two diseases is striking.

Two differences were noted. First, mucosal ulceration was prominent in regional ileitis and was much less marked in fibroplastic appendicitis. Second, giant cells were frequent in the sections studied from our cases of regional ileitis and were not observed in fibroplastic appendicitis.

The fact that there is little or no fecal current in the appendix may explain the frequent preservation of the intact mucosa in this organ. The second difference, while constant in the cases reported here, has not been constant in the experience of others, as giant cells do not always occur in regional ileitis.

The first cases of fibroplastic appendicitis were reported by von Bergmann.[21] The name, however, was suggested by Läwen,[22] who gave a more precise description of the lesion and distinguished inflammatory tumors arising from the appendix but involving the surrounding gut and omentum in a conglomerate mass (fibroplastic appendicitis in the broader sense) from inflammatory tumors arising from the appendix and remaining largely confined to it (fibroplastic appendicitis in the narrower sense).

Approximately 150 cases of regional ileitis have been reported, although in many instances data were not published which would make possible careful analysis or final verification. In 1921, Bachlehner[23] collected 41 cases of fibroplastic appendicitis which had been reported. These are not listed individually but the figure must include "fibroplastic appendicitis in the broader sense." Since then we have found reference to 13 other cases which have been reported.

Regional ileitis occurs more frequently in males than in females. It has been observed in patients ranging in age from four and one-half to 70 years, although it is most frequently observed from the second to the fourth decades.

A study of the symptomatology of the disease as it occurred in our patients, and in the reported cases, enables one to differentiate four moderately clearly defined types, the first resembling acute appendicitis, the second colitis, the third chronic intestinal obstruction and the fourth being distinguished by intractable fecal fistulae. In some cases the clinical picture advances from one type of symptomatology to another.

The patients with a symptom complex similar to appendicitis may be diagnosed only at operation. The appendix at operation may be the site of an acute process but in other instances the reddened appendix may be involved only by contiguity and show no histologic evidence of mucosal inflammation. Those in whom the picture simulates an ulcerative colitis may present a mass on physical examination, but the true diagnosis may not be determined until a complete roentgenologic gastro-intestinal examination has been made. In this group there are often slight fever, a loss of weight and a moderately profound anemia. In patients with a picture of acute or chronic intestinal obstruction the diagnosis may be made only at operation. It is significant that at this stage a mass is usually palpable.

The disease, as has been pointed out, as a rule affects young people. The history frequently covers a long period of gastro-intestinal disturbance.

FIG. 6.—Roentgenologic appearance of the "string sign" in regional ileitis.

FIG. 7.—Roentgenologic appearance of the "string sign" in regional ileitis.

FIG. 8.—Roentgenologic appearance of the "string sign" in ileocecal tuberculosis.

Anemia, while marked, is not as severe as that seen in carcinoma of the cecum or ascending colon.

The roentgenologic findings are diagnostically important. In the early stages fluoroscopic study will disclose variable degrees of ileal stasis (Figs. 6, 7 and 8). As the fibroblastic proliferative phase of the disease gives rise to a progressive stenosing enteritis, ileal stasis is increased and the small intestine above the involved area becomes somewhat dilated. Filling defects may occur. Kantor's[24] "string sign" of the terminal ileum is strongly suggestive but not absolutely indicative of the disease, since any lesion intrinsic or extrinsic to the intestine which leads to stenosis may give rise to a similar appearance. Early in the course of the disease there is, as a rule, no defect of the cecum, but the presence of a defect should not weigh strongly against the diagnosis, since in the later stages cecal defects due to spasm, adhesions, or actual cecal involvement by the disease are not uncommon. We have not observed a "string sign" in fibroplastic appendicitis, but a cecal defect is present in the later stages of the disease, and distortion and adhesions may result in ileal deformity during roentgenographic visualization.

We have observed personally in the past two years six cases of regional ileitis and two of fibroplastic appendicitis (Table I).

TABLE I

CASES OF REGIONAL ILEITIS

Patient	Age	Stage of Disease	Treatment	Final Result
J. G.....	28 yrs.	III	Ileocolostomy, incomplete	Persistence of cramp-like pain. Resection attempted in another hospital—death
M. K.....	18 "	IV	Resection	Excellent
E. G.....	36 "	II	Resection	Excellent
S. B.....	18 "	III	Ileocolostomy, complete	Fistula formation later. No obstruction
I. D.....	31 "	V	None	Death from peritonitis
H. D.....	48 "	I	Appendicectomy	Some digestive symptoms

Stage of the Disease

Stage I—Acute stage
Stage II—Sclerosing—Resectable
Stage III—Sclerosing—Nonresectable
Stage IV—Fistula formation
Stage V—Peritonitis

The case history of one of the patients with fibroplastic appendicitis and that of a typical case of terminal ileitis are appended.

Case 1.—Fibroplastic Appendicitis: E. A., age 23, dental student, admitted to the Hospital of the University of Pennsylvania, February 27, 1934.

The patient's symptoms began six weeks earlier when he had an attack of diarrhea followed by sharp stinging pains in the epigastrium, coming on about one hour after eating. These subsided after a day of fasting, after which the patient was placed on a bland, smooth diet. There followed a period of soreness and a sense of discomfort in the epigastrium. Abdominal discomfort without clear relation to meals persisted.

Two weeks before admission the patient had burning on urination for a few days followed by tenderness in the right lower quadrant. Four days before admission intermittent knife-like pain developed in the right lower abdomen. There was some nausea but no vomiting. The pain subsided somewhat after three days' rest in bed. On the day of admission a mass was palpated in the right lower quadrant for the first time. Past medical history and the family history were negative.

Physical Examination showed a well developed white male not acutely ill. Temperature 98.4° F.; pulse 72; respiration 18. Blood pressure 116/80. Heart and lungs normal. A large, irregular mass was palpated occupying the lower two-thirds of the right lower quadrant of the abdomen, over which there was muscular rigidity. The leukocyte count was 7,700. After two days' observation, celiotomy was performed.

Operation.—The anterior parietal peritoneum was edematous and adherent at several points to the underlying mass. The latter was composed of omentum wrapped around a huge, firm appendix measuring 4.5 cm. in diameter and 10.5 cm. in length (Fig. 9).

When the appendix was separated from its attachments, the induration was found to extend to the cecal wall. The appendix was excised from the cecum and the opening in the cecum closed around a 6 Mm. rubber cecostomy tube. Culture of the peritoneal fluid showed a hemalytic Staphylococcus aureus.

FIG. 9.—Drawing showing enormous thickening of the wall of the appendix due to fibroblastic proliferation in an instance of fibroplastic appendicitis.

There was a sharp febrile response which reached 104.2° F. on the second postoperative day. This rapidly came down to normal, however, and an uncomplicated convalescence ensued. The fecal drainage subsided soon after removal of the cecostomy tube. The patient has remained well.

Pathologic Report.—Gross examination by Dr. A. E. Bothe. The outer surface of the appendix was roughened and the wall was thickened, pale and firm. The lumen was very small and there was a constriction at the junction of the lower and middle third.

Microscopic.—Marked fibroblastic proliferation is present to an unusual degree. There are evidences of a chronic inflammatory lesion and a more recent acute inflammatory reaction. The picture is that of fibroplastic appendicitis.

Case 2.—Regional Ileitis: E. G., age 36, white woman, admitted to the Hospital of the University of Pennsylvania, May 1, 1935, on the service of Dr. Alfred Stengel and transferred two weeks later to the Surgical Service.

The patient had had diarrhea and epigastric pain for several years. These symptoms were noticeably more severe during the last four years. There was occasional vomiting for four years. She had had a gastropexy in 1931, but was only temporarily relieved.

A mass was first noted in the right lower quadrant of her abdomen in 1932. Her weight had declined 31 per cent during the four years preceding admission.

Gastro-intestinal roentgenologic studies disclosed a lesion involving the terminal ileum and ascending colon which Dr. E. P. Pendergrass suggested might be a granuloma. The stools were negative for acid fast organisms and a tuberculin test was negative with .01 mg. of old tuberculin.

On May 21, the terminal ileum, cecum, and ascending colon were resected and the proximal end of the divided ileum anastomosed to the transverse colon. Convalescence was smooth except for the development of a nutritional edema, which was relieved promptly by repeated blood transfusions.

Pathologic Examination.—Gross by Dr. A. E. Bothe. There is marked thickening of the wall of the terminal ileum for a distance of approximately 15 cm. The thickening is most marked near the ileocecal valve, the last few centimeters of ileum having a wall 8 Mm. thick. The process stops abruptly at the ileocecal valve.

Microscopic.—The main features are fibrous hyperplasia involving all layers and leukocytic infiltration. In addition there is considerable ulceration of the mucosa. Scattered throughout the section are giant cells of foreign body type. A number of sections were stained for acid fast organisms without result.

The patient has been greatly improved. She occasionally has a loose stool. Her weight during the first ten months postoperative increased from 87 to 142 pounds.

The majority of cases of regional ileitis have been treated by ileocolostomy with or without division of the ileum or by resection in one or more stages (Figs. 10, 11 and 12). The results following resection have in general been very good. Of the recovered cases all have been cured except one case of Homans and Hass,[15] which suffered a recurrence both of symptoms and of abnormal roentgenologic findings. These authors suggested that reinfection of the ileum at the ileocolostomy might have occurred from the mesenteric lymph nodes.

Loose bowel movements occurring several times a day are not uncommon after the operation but in most cases have not been troublesome. The only other reported complications were a fecal and urinary fistula, which occurred together in the case reported by Phillips.[25] These were finally closed and the patient recovered after a second ileocolostomy.

Ileocolostomy alone has been used successfully in some of the reported cases but in the single patient in whom we employed this procedure the relief from symptoms was not satisfactory. The patient, while relieved from acute obstructive symptoms, continued to have attacks of cramp-like pain. The lesion was so densely adherent that resection, with any degree of success, did not seem possible. We offered to divide the ileum distal to the anastomosis but the patient refused to permit this. An attempt was made to resect the lesion in another hospital but the patient did not survive the operation.

There is, of course, danger of extension of the pathologic process along the ileum to the site of anastomosis, if the ileum is not divided, and to contiguous structures if it is divided, but not resected.

Ileocolostomy with division of the ileum between the anastomosis and the involved portion would appear to be the best procedure when resection is not possible. When this is done the ileum should be divided well above

FIG. 10.—Drawing illustrating the procedure of ileocolostomy in continuity.

FIG. 11.—Drawing illustrating the procedures of ileocolostomy with division of the ileum.

FIG. 12.—Drawing illustrating the appearance after an ileocolostomy with resection of the lesion.

FIG. 13.—The gross postmortem specimen from a case of regional ileitis with multiple perforations.

the lesion. In one patient in whom we have done this a fistula resulted from the side-tracked bowel.

In the one patient who was admitted with peritonitis, operation would have availed nothing. He was admitted five days after the onset of perforation, in the terminal stages of peritoneal suppuration. The diagnosis was not made until autopsy (Fig. 13).

In two patients in our series whose lesions were not resectable, an attempt was made to treat the area with deep radiation. The results have not been promising.

The boundaries of the original concept of regional ileitis have by now so far broken down that the term has become more confusing than helpful. The tendency of such lesions, when they occur in the ileum, to stop at the ileocecal valve remains very striking. The earlier concept, of Crohn and his associates, that the disease involved only the terminal ileum has given way to the now more generally accepted idea that no portion of the jejunum, ileum or proximal colon is immune from it.[19] It is doubtful if any classification of the nonspecific granulomata and fibroplastic processes of the intestine will be entirely satisfactory unless their etiology becomes known. At this time this is purely a matter of speculation.

It can be seen from a description of regional ileitis and of fibroplastic appendicitis that the conditions are in many respects quite similar. While the one has a predeliction for the terminal small bowel and the other for the appendix, a survey of reported cases shows that neither disease is strictly limited along anatomic lines. From a review of the literature it would seem that these are rare lesions, but our recent experience would lead us to believe that they are probably much more common than we have previously considered them to be. Surely there must be many instances of milder phases of the disease in which the correct diagnosis is not made and of later stages where the diagnosis is confused with tuberculosis, actinomycosis or malignancy. A case of the last type has recently come to our attention.

The long period of disability and frequent fatal outcome that follows incorrect diagnosis is sufficient to indicate the importance of thorough investigation of every patient who is suspected of having either of these conditions. The exact incidence of their occurrence must await further reports from surgeons and clinicians who may have the opportunity of observing them. The only hope of prevention of the inoperable condition, which comes late in the disease, is early and efficient surgical treatment.

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DISCUSSION:

DR. DAMON PFEIFFER (Philadelphia).—Doctor Ravdin has thoroughly discussed the subject of terminal ileitis from every angle except that of the management of the early stage of the process. The treatment of the advanced condition seems to have been quite well standardized but little seems to have been accomplished in preventing the need for radical surgery. I know that Doctor Ravdin has had experience in the use of roentgenotherapy in several patients and I would like to hear his opinion as to its value in the early stages of the disease.

Last spring I had the opportunity of operating upon a six year old boy with an early stage of this condition. His cecum and first part of the ascending colon as well as the terminal ileum were involved in an acute inflammatory process, with marked hyperplasia of the mesenteric lymph nodes draining this region and secondary involvement of the appendix. The appendix was removed and on the next day roentgenotherapy to the abdomen was administered. His recovery was uneventful. (A gastro-intestinal series made before his discharge showed evidence of involvement of a higher part of the ileum.) He has been followed since then without evidencing any further trouble. A second course of roentgenotherapy was given one month after discharge from the hospital. This case would seem to be of particular interest because of the use of roentgenotherapy in the early stage of the disease.

The patient was restudied November 11, 1936. He was found to complain of soreness of his abdominal wall and hyperesthesia around the umbilicus. His appetite was poor and he was not gaining weight. He was readmitted to the hospital, and another G. I. roentgenologic study was made. Much more extensive involvement of the ileum was evident than in previous

examinations and there was a very definite change in contour of the terminal ileum. After two days in the hospital all of his symptoms disappeared and the abdomen became normal to palpation. His tonsils were found to be badly diseased and were removed. He has been discharged again with a good appetite and symptom free. He will have another G. I. series within two weeks.

Dr. Ralph Goldsmith (Philadelphia).—I should like to supplement Doctor Ravdin's remarks concerning the lack of complete reliability of the "string-test." Two patients came under my care last year, one of whom was a young woman with subacute appendicitis and in whom ileocecal tuberculosis of mild degree was found. After her recovery from the appendicectomy, roentgenograms were taken and there was found a typical "string" appearance of the terminal ileum which was not in the least characteristic of tuberculosis but represented what one considers as indicative of terminal ileitis. The other case was a man who came to the hospital with a history of loss of weight, long standing history of mild pain, constipation and a mass in the lower abdomen and apparently a perforation. After careful consideration we made a diagnosis of terminal ileitis with perforation. He was very ill, almost moribund, and we had to treat him conservatively until operation could be performed more safely; but like many patients, when he felt a little better, he went home. He gained weight rapidly. After a year he was radiographed and he showed no deformity. I believe that he had had a perforated appendix and had never had terminal ileitis at all and that the extra-intestinal lesion had produced the "string sign."

Dr. Walter E. Lee (Philadelphia).—Doctor Ravdin's paper leaves very little for discussion, as he has not only brought the literature up to date, but has not introduced any controversial phases. It seems to me that his real contribution consists in calling attention to the remarkable similarity in the pathology of the lesion known as fibroplastic appendicitis and that of regional or terminal ileitis, and as far as I know, this is the first observation of this kind. It has been usual to find the same changes in the wall of the appendix as in the walls of the terminal ileum. I feel that this is an important contribution, and with the large number of cases of terminal ileitis which are being recognized at the present time by clinicians, we soon should be able to determine whether or not these two lesions have the same pathologic changes.

TUBERCULOSIS OF THE CERVIX

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TUBERCULOSIS of the cervix is a rare disease. The first case was described by Morgagni in 1744. Norris[31] reports that in 15,130 specimens in the Obstetric and Gynecologic Laboratory of the University of Pennsylvania there are 74 specimens of genital tuberculosis, of which only four are of the cervix. Comyns Berkeley,[5] in 798 autopsies upon women who died of tuberculosis, found the reproductive tract involved in 62 or 7.7 per cent. Of these the uterus was invaded in 21 instances, the disease being limited to the body in 17 and to the cervix in three. In one case only were both affected. The tubes were infected in 80.6 per cent. It is probable that tuberculous invasion of the cervix is more frequent than the figures given in the literature indicate. A very usual method of dealing with tuberculous disease of the tubes and ovaries is subtotal hysterectomy, leaving the cervix in situ. The presence of tuberculosis in the cervix may thus escape recognition and may heal after the removal of the more extensive lesions above, as does tuberculous invasion of the contiguous peritoneum. Healing may be favored by the cessation of invasion by bacilli coming down from the endometrium and tubes.

Four types of tuberculous invasion are distinguished: The ulcerative, the miliary, the papillary and the interstitial. The ulcerative type is usually characterized by a single lesion, the edges of which are rather well defined. The ulcer bleeds easily upon contact but less so than in instances of carcinoma.

The papillary type may be confused with carcinoma, which it may resemble closely. In the miliary variety the cervix is enlarged and small miliary tubercles may be visible on the surface. The interstitial type appears first in the substance of the cervix, forming a nodule which may become necrotic. The necrotic material may be discharged, leaving a cavity.

Tuberculosis of the cervix is, in the great majority of cases, secondary to lesions at higher levels. These, in turn, are usually preceded by lesions elsewhere, usually in the lungs, from which the tubercle bacilli find their way to the pelvis through the blood stream. The method of progression from the uterine body to the cervix may be by continuity of tissue, through the lymphatics or by the blood stream. The latter is the usual route of infection to the genital tract from an already existing pulmonary tuberculosis. Jameson in his recently published monograph on Gynecological and Obstetrical Tuberculosis states that blood stream infection of the cervix has not been demonstrated. Basso[4] showed experimentally that injection of tubercle bacilli would produce tuberculous lesions at any point but that extension occurred downward in the direction of the flow of the uterine secretions.

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In most of the reported cases the vaginal portion of the cervix is involved, the endocervix being comparatively infrequently invaded. Jameson believes that it is an ascending infection, the bacilli either gaining entrance from without and attacking the cervix or descending through the cervical canal into the vagina from whence the cervix is infected, the bacilli invading the cervical tissue. In either case the infection is an ascending one. It is probable that infections from without are rare. The number of tuberculous cervical lesions in the wives of men who have tuberculosis of the testes, seminal vesicles or bladder, is very small.

Norris believes that in 75 to 80 per cent of cases, tuberculosis of the cervix is associated with tuberculosis of the upper genital tract. Watson is of the same opinion.

The symptoms of tuberculous infection of the cervix may not be marked. The evidences of cervical disease may be overshadowed by those of the adnexal involvement which is so frequently present. A moderate leukorrhea may be present but bleeding is usually absent or small in amount. Any excessive bleeding is likely to be due to a disturbance of ovarian function caused by tuberculous invasion. Tuberculous cervical lesions may be confused with venereal disease or may be mistaken for carcinoma. The latter is far more common and differentiation is important. The typical induration characteristic of carcinoma is absent and the lesion does not bleed as easily upon contact. Examination of smears may reveal the tubercle bacillus but care must be taken that it is not confused with the smegma bacillus.

The removal of a small piece of tissue for microscopic study is the most satisfactory method of diagnosis. Animal inoculation may be used but is time consuming and no more conclusive than histologic examination. For biopsy the specimen must be of sufficient size that the pathologist can make satisfactory sections. These should include the mucosa and the fibromuscular structure of the cervix. A biopsy specimen which consists only of necrotic material from an ulcerated area is of little value.

Should the suspected lesion prove to be carcinoma, the time expended in excluding tuberculosis by animal inoculation will seriously delay the beginning of treatment of the malignant disease.

Syphilis of the cervix may be suspected but a Wassermann reaction is not conclusive, as syphilis and tuberculosis may be found in the same individual.

Should the cervical disease prove to be tuberculous, a careful search must be made for tuberculosis elsewhere. The involvement of the upper levels of the reproductive tract and contiguous peritoneum may be more important than the disease of the cervix. Pulmonary examination, including roentgenography, is essential, as treatment of what was probably the primary lesion must not be neglected.

As tuberculosis of the cervix will be mistaken for carcinoma far more frequently than it will be confused with any other disease, the necessity for immediate differentiation is apparent. Irradiation of a tuberculous cervix is a therapeutic error, as the insertion of radium preceded by the necessary dilatation of the cervix predisposes to the spreading of the disease. The

literature contains a number of reports of cases in which radium therapy was employed because the suspected lesion was thought to be carcinoma. The radical surgical procedures, which are employed in the treatment of cervical cancer, subject the woman with a tuberculous cervix to a greater risk than is necessary.

Counseller and Collins[14] have assembled 109 cases, including one of their own. Of these, 11 were primary and five were questionably primary. Tuberculosis of the cervix was histologically demonstrated for the first time by Cornil,[12] in 1879. Brouardel[9] refers to tuberculous disease of the cervix in a thesis, in 1865, but considers it exceptional. The same view is expressed by Klob[23] in his text-book, in 1864. Beyea[6] in 1900 collected 69 cases. Chaton[11] published an exhaustive study in 1908 and assembled 87 cases, of which one was his own.

Watson in 1934 reported a case of tuberculosis of the cervix. In this case no involvement of the endometrium and myometrium was found, but tuberculous changes were found in the tubes. In the discussion of this case Dannreuther reported a case of primary tuberculosis, evidently a contact infection. The possibility of infection of the cervix by coitus was denied by Hantham, Simonds, Jacquart and Reclus, but does probably occur rarely, as suggested by Dannreuther's case.

The case here reported is the only proved case of tuberculosis of the cervix which I have seen or which has occurred in our service.

Case Report.—A woman of 60 complained of a vaginal discharge which, for two months preceding examination, had been sufficiently profuse to annoy her. She also had some backache and some lower abdominal discomfort but no pain.

Examination disclosed a normal vagina except for slight relaxation at the outlet. The cervix was of normal size. A moderate endocervicitis was present with some yellowish discharge. On the visible portion of the cervix there was a somewhat irregular ulceration which was not deep and which, when first seen, gave the impression of a malignant growth. The typical induration of carcinoma was, however, absent. It did not bleed upon contact as easily as carcinoma ordinarily does. The uterus was normal in size, anteflexed, mobility rather less than normal. A moderate bilateral adnexal tenderness was elicited but no mass was appreciated. As the process was not characteristic of carcinoma, a biopsy was performed.

Pathologic Examination.—Gross: "Two small pieces of soft pink tissue 1.1. x 0.8 x 0.4 cm. by 0.4 x 0.4 x 0.2 cm. *Microscopic:* Sections of this tissue disclose chronic inflammation, extensive fibrous tissue proliferation, cellular invasion, small areas of necrosis with 'giant cell' formation, typical lesions such as are seen in tuberculosis. *Diagnosis:* Tuberculosis of the cervix."

Operation.—A complete hysterectomy was performed, excising the upper margin of the vagina and both tubes and ovaries. The adnexa on both sides were firmly adherent in the culdesac. There were rather extensive adhesions between the sigmoid and omentum and the pelvic organs. A few tubercles were found upon the adjacent bowel. Because of the denudation of the pelvic floor, caused by separation of adhesions, peritonealization of the left half of the pelvic floor was accomplished by attaching the sigmoid over it by a few interrupted sutures. Recovery was without incident.

Pathologic Examination.—Gross: "A uterus together with its cervix, recently amputated, 8 x 6 x 3 cm., together with one ovary 3 x 2 x 1.2 cm., with both fallopian tubes 6 x 0.6 and 5.4 x 0.8 cm., attached. The cervix is eroded on one side by an irregular ulcerated

patch, having a rough floor with numerous white spots. The outside of the tubes is torn in several places as if from extensive fibrous adhesions. The uterus is flabby, atrophic and has a hard nodule in its wall 2.5 cm. in diameter. The endometrium is eroded, thrown up into folds, and somewhat indurated.

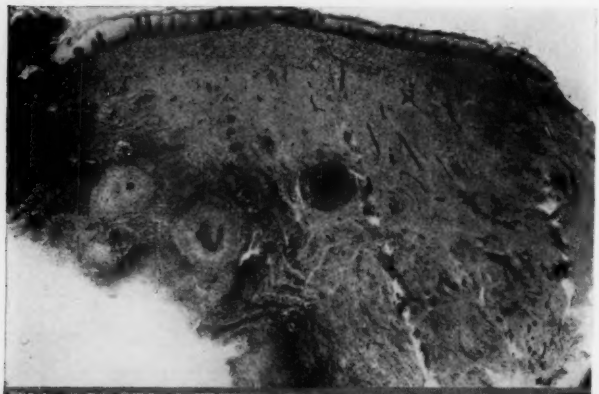

FIG. 1.—Section of the cervix showing tubercles.

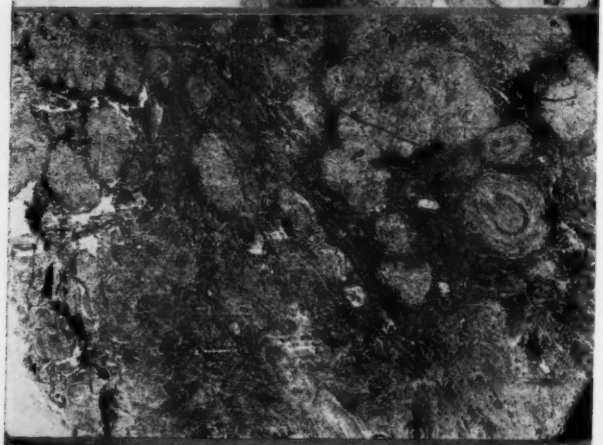

FIG. 2.—Section of corporeal myometrium showing extensive tuberculous invasion.

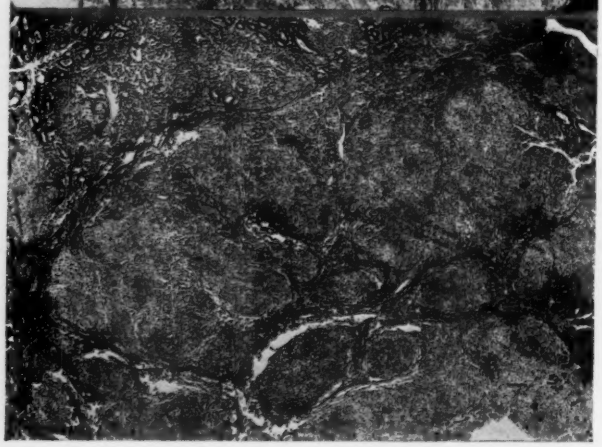

FIG. 3.—Section of uterine wall immediately under the endometrium showing tuberculous infection.

"One fallopian tube is so extensively involved in fibrous adhesions that its outline is indistinct, its fimbriated extremity is reddened and sealed off. The lining mucous membrane is also reddened. The opposite fallopian tube has an occluded lumen and the fim-

briated extremity is missing. One ovary has undergone an extensive fibrous tissue change.

"*Microscopic:* Sections through tissue of the cervix disclose numerous areas of caseation, necrosis, fibrosis and giant cell formations arranged in multiple small tubercles (Fig. 1). Sections through the endometrium disclose similar changes (Figs. 2 and 3). Sections through fallopian tube disclose extensive scar tissue formation, small amount of chronic inflammation. Sections of the ovary reveal extensive tissue change. Smears of cervix and endometrium are stained for acid fast bacilli.

"*Diagnosis:* Tuberculosis of cervix and of the uterus. Sections of this tissue (cervix and endometrium), stained for tubercle bacilli, when examined microscopically, contain a few acid fast bacilli."

TREATMENT.—If the condition of the patient permits, the best management is complete hysterectomy. If the strength of the patient does not warrant radical surgical intervention, or if extensive tuberculous invasion of the peritoneum renders cure very improbable, operation may be withheld. Pulmonary involvement sufficiently advanced, that the pelvic tuberculosis is of secondary importance, renders operative treatment of the pelvic tuberculosis unwise.

If it is quite certain if the cervical tuberculosis is primary, amputation of the cervix will suffice. It is, however, difficult to be sure of this without an inspection of the reproductive organs and contiguous peritoneum from above. As primary tuberculosis of the cervix, or tuberculous disease limited to the cervix, is found in only one-fifth to one-fourth of the cases of cervical tuberculosis, it is wise to pursue a course which will give the woman the greatest chance of cure.

Among the less radical forms of treatment which have been suggested are cautery amputation of the cervix, electrocoagulation, cauterization, and amputation of the cervix. These are all unsatisfactory in that they deal with the cervix only, and leave untouched the upper portion of the reproductive tract, which is involved in at least 75 per cent of the cases.

In the case herewith reported the patient has remained well for seven years. When last examined, one month prior to the preparation of this report, she was in excellent health and showed no sign of tuberculous disease of the pelvis or any other part of the body.

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A CYSTOMETRIC STUDY OF THE FUNCTION OF THE URINARY BLADDER

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RECENT developments in cystometry have rapidly increased the clinical significance of the function of the urinary bladder. Mosso and Pellacani[10] (1882) were among the earlier investigators of the physiology of the bladder and recorded their observations on the smoked drum kymograph which had just been introduced. A review of the subsequent literature reveals very little cystometric work until D. K. Rose[15] (1927) reported the construction of a clinical cystometer and discussed its applications. Rose and his collaborators have continued their investigations to the present time and clinical cystometry is largely the result of their efforts. Our understanding of the function of the urinary bladder, however, is not at all complete, and we have therefore thought it of importance to report a few observations made on normal and some abnormal bladders.

Method.—Since the introduction of the Rose cystometer, several others have been devised, variously simplified, and more easily adaptable to everyday use (Hirsch,[3] 1928; Redewill,[14] 1928; McKinlay,[9] 1932; Muschat and Johnson,[12] 1932; Schultz,[17] 1935; and Simons,[18] 1935). Examination of these instruments and the records obtained from them shows that whereas they are adequate for the demonstration of qualitative differences in bladders for clinical purposes, they are inadequate for an accurate physiologic study of bladder function. Most cystometers have employed a mercury manometer and an air trap in the system, making the apparatus relatively insensitive in that a lag is introduced and small variations in pressure are not reflected by a mercury manometer. The cystometrograms reported have been made in the space of from two to 20 minutes and we believe that this is done far too rapidly since the bladder is not given an opportunity to accommodate to its new volume after each determination. It has been argued that for true cystometrograms, the bladder should not be allowed to accommodate to its increased content before the reading is taken. The point is a debatable one, but it seems more accurate to allow the bladder to attain a resting level for each reading, if one is to interpret the cystometrogram as a graphic representation of the ability of the bladder to accommodate changing volumes. Finally, the cystometrograms in the literature show a scarcity of points along the curves, making an accurate demonstration of slope changes impossible. Langworthy and Kolb[4] (1933), however, have devised an excellent apparatus which meets most of these objections.

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The apparatus we have used consisted simply of a burette and a water manometer connected directly to a catheter through the arms of a glass Y-tube. The catheter, often the inlying catheter of patients on constant drainage, was usually a plain soft rubber catheter Eynard No. 18 or 20. The burette and the manometer could be separately cut off from the rest of the apparatus by conveniently placed clamps on the arms of the Y-tube. The apparatus could be sterilized by rinsing with 70 per cent alcohol and the catheter by boiling. The manometer and burette were mounted on a stand and arranged on a bedside table so that the afferent arm to the manometer was in the same horizontal plane as the symphysis pubis of the subject. With

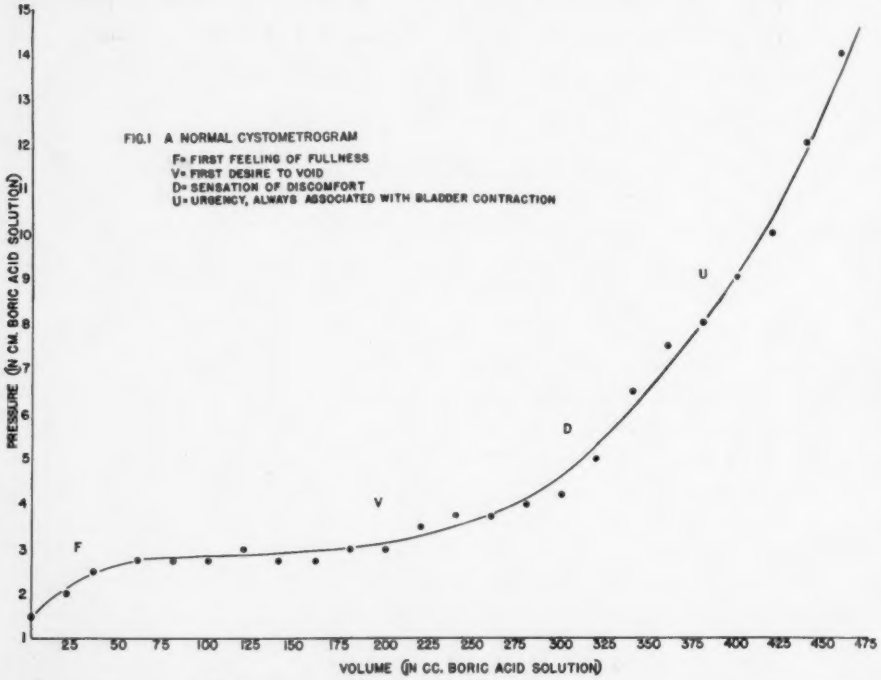

PRESSURE (IN CM. BORIC ACID SOLUTION)
VOLUME (IN CC. BORIC ACID SOLUTION)
F
V
D
U
25 50 75 100 125 150 175 200 225 250 275 300 325 350 375 400 425 450 475

FIG. 1 A NORMAL CYSTOMETROGRAM
F= FIRST FEELING OF FULLNESS
V= FIRST DESIRE TO VOID
D= SENSATION OF DISCOMFORT
U= URGENCY, ALWAYS ASSOCIATED WITH BLADDER CONTRACTION

the bladder empty, the manometer reading at this point was considered "zero" or basal. The burette was then filled with 1:50 boric acid solution and 20 cc. of the solution were allowed to enter the bladder at a rate so slow as to produce only an insignificant rise (0.5 to 1.0 cm.) in the manometer, which was kept in communication with the bladder throughout the time the fluid was introduced. The manometer was read one to two minutes after each introduction of fluid. Each reading, therefore, required two to four minutes to complete. A sufficient number of points were determined to ascertain the shape of the cystometric curve throughout its course, and the subjective experiences of the patient were recorded at their corresponding points in the curve. Check determinations were not made with decreasing volumes because the time needed for each cystometrogram was often as long as two hours and it would have been difficult to obtain the necessary co-

operation of the patient for longer periods of time. At the end of the experiment, the bladder was emptied and the excess obtained over the total volume injected was recorded as the volume of urinary secretion during the period. This was considered a constant error and no correction has been made for it. Permanent records were obtained when desired by connecting the top of the manometer with a Brodie bellows which was set up to trace on a smoked drum kymograph.

Results.—The Normal Cystometrogram: Cystometrograms were studied in 16 patients with clinically and, in 11 cases, cystoscopically normal bladders. A curve relating bladder pressure and intracystic volume was found typical for all cases (Fig. 1). The initial 60 to 100 cc. of fluid produced a relatively rapid rise in bladder pressure to about 3 or 5 cm. of water. The slope of the curve then flattened and approached a horizontal level. At pressures of 3.5 to 7.0 cm. of water with 250 to 400 cc. of fluid the curve began to rise steeply again until it became almost vertical at an average pressure of 16 cm. and a volume of 450 to 600 cc. of fluid.

Spontaneous bladder contractions were practically never seen until the cystometrogram had begun its steep rise. When the bladder contained about 400 cc. of fluid at a pressure of about 5 to 8 cm., small irregular spontaneous bladder contractions began to appear and became gradually larger until toward the end of the curve they developed a pressure often exceeding the height of the manometer (95 cm.).

The noting of bladder sensations during distention of the organ is a routine part of cystometry. It has been generally agreed that under normal conditions the first desire to void is at intracystic volume of 150 cc.; fulness at 300 cc.; and discomfort at 400 cc. These sensations were studied with particular reference to the first perception of fluid in the bladder, the first desire to void, and the first feeling of discomfort. The results in the cases studied do not show a close correlation between subjective bladder sensations and either intracystic volume or pressure, each of which has varied more than 100 per cent for the different sensations. Instead, subjective experiences appear to be more closely related to those points in the cystometrogram at which the shape of the curve changes. For convenience, the curve might be divided into three parts: (1) The initial rise; (2) the relatively flat area; and (3) the final sharp rise. The perception of fluid in the bladder has come usually at the transition of the first into the second division of the curve. The desire to void did not appear until the latter part of the second region of the curve, and discomfort was not experienced until the third portion of the curve when the slope began to increase rapidly.

Urgency was found to be associated with isolated rises in bladder pressure and only when these were due to *active* contraction of the bladder (Fig. 2). The patient complained of urgency at the very beginning of bladder contraction when the intracystic pressure was still relatively low. He was relieved as soon as the bladder began to relax in spite of the fact that the intracystic pressure had not yet decreased appreciably. From these observa-

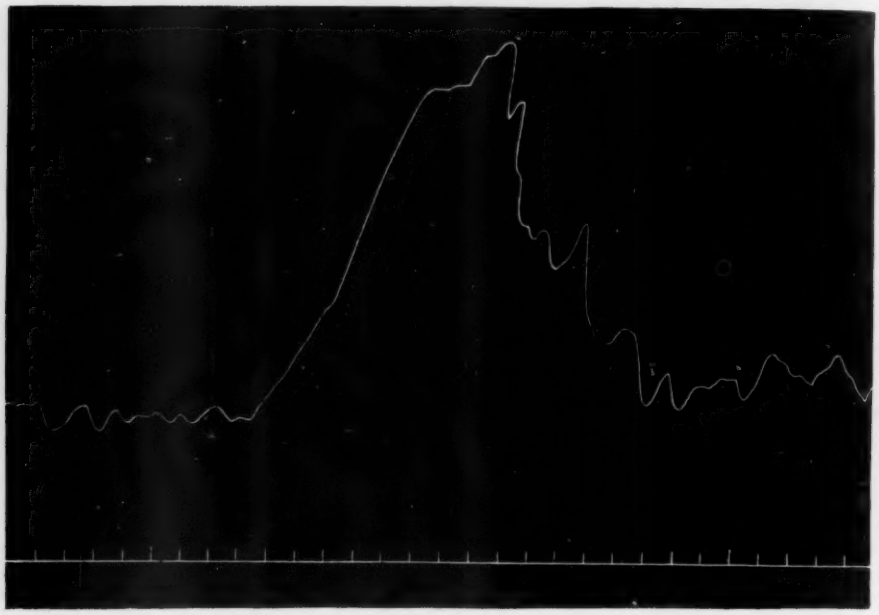
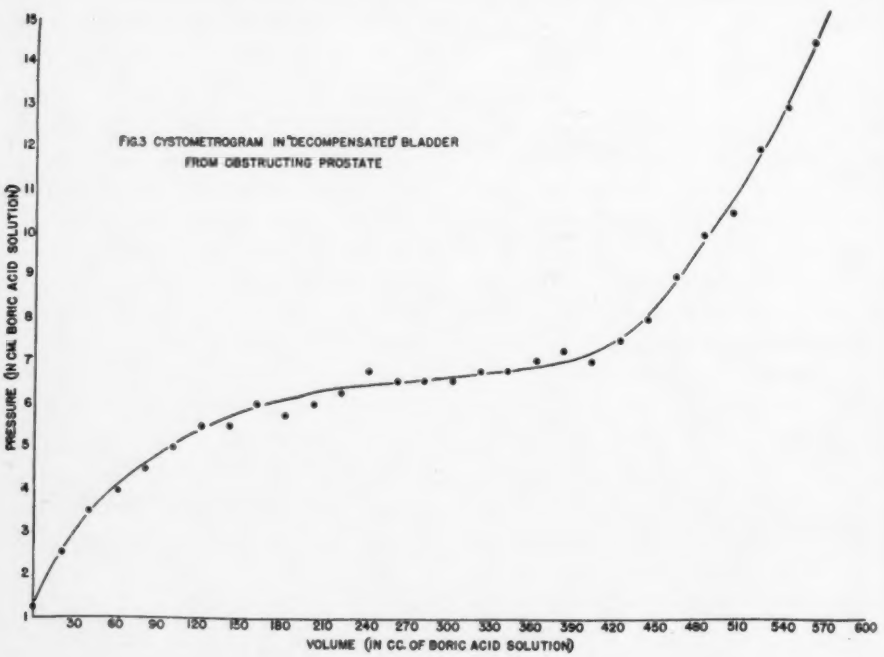
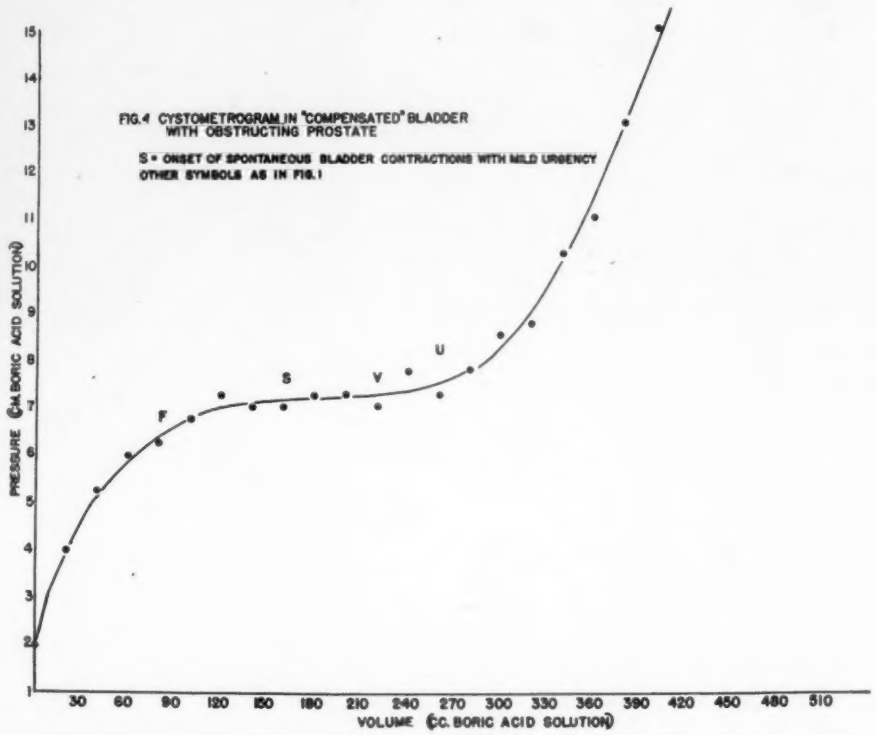


FIG. 2.—A cystometrogram of a bladder contraction (spontaneous) associated with urgency. The patient was relieved with the very beginning of the relaxing phase in spite of high intracystic pressure.



tions, then, it seems that urgency is a consequence of the active attempt of the bladder to empty itself against resistance. The severity of the urgency depends upon the magnitude of the contraction.

The Cystometrogram in Obstruction from Benign Hypertrophy of the Prostate.—The cystometrograms were studied in ten cases of benign prostatic obstruction. Two of these were studied immediately after decompression for acute retention and they were of interest in that there was in each an extraordinary lack of sensation in spite of large volumes of fluid injected, resembling the tabetic bladder in this respect (Fig. 3). In neither was there



any desire to void even after the injection of 650 cc. of fluid. At this point, however, one patient began to have feeble bladder contractions accompanied by urgency and the other complained merely of a "dull backache." The shapes of the curves were different from the normal in that the initial rise did not cease until a pressure two or three times the normal had been reached, when the slope began to decrease. Subsequent cystometrograms showed a gradual return of normal sensation and bladder "tone," but the high initial rise persisted and this has been characteristic of the ten bladders examined (Fig. 4).

The Cystometrogram in Cystitis.—Observations were made on a bladder with decreased capacity and very early appearance of subjective sensations. The tests were repeated at intervals in this case, and the curves were found

to approach gradually the normal. The cystometric improvement went parallel with both clinical and cystoscopic improvement. These observations confirm those already reported in the literature.

The Cystometrogram in Megacolon.—We had the opportunity to study the case of a boy, age 17, admitted to the hospital because of constipation for several months and obstipation for ten days. Physical examination showed painless abdominal distention and a very large fecal impaction. A cystometrogram was made and its shape was found to resemble that of the curve for acute cystitis (Fig. 5A). Bladder discomfort and urgency came early along with the early steep rise and the early appearance of bladder contractions. If Figure 5A is plotted on a different scale (Fig. 6), the shape of

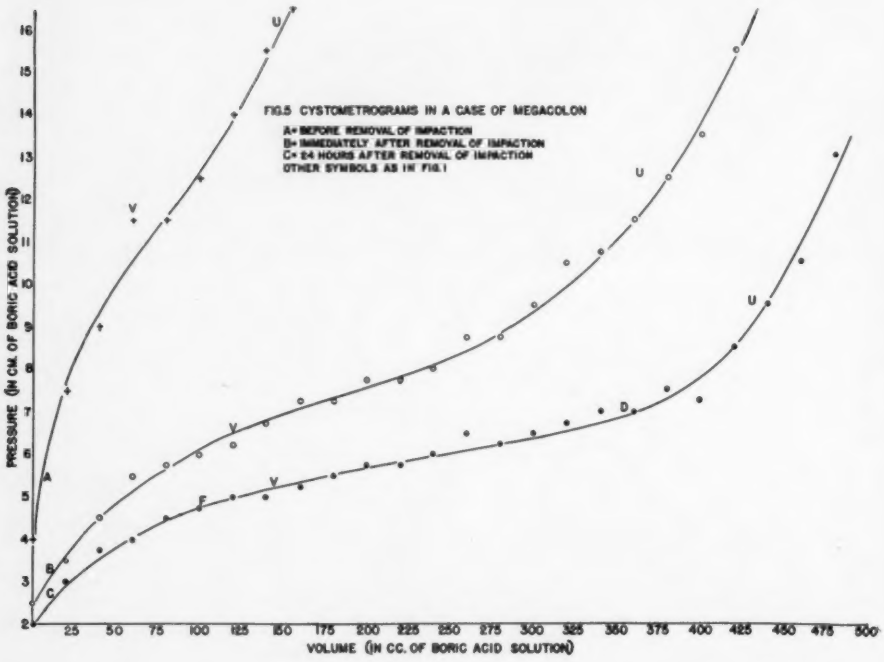


FIG.5 CYSTOMETROGRAMS IN A CASE OF MEGACOLON
A= BEFORE REMOVAL OF IMPACTION
B= IMMEDIATELY AFTER REMOVAL OF IMPACTION
C= 24 HOURS AFTER REMOVAL OF IMPACTION
OTHER SYMBOLS AS IN FIG.1
PRESSURE (IN CM. OF BORIC ACID SOLUTION)
VOLUME (IN CC. OF BORIC ACID SOLUTION)

the curve is found to resemble that of a normal cystometrogram. This might be interpreted as demonstrating that the abnormality is referable simply to a decreased capacity of the bladder without autonomic imbalance.

The cystometrogram was repeated about two hours after removal of the impaction (about six quarts of fecal matter) under spinal anesthesia (Fig. 5B). The curve is nearly normal, its slope being still relatively increased. A third cystometrogram was made on the following day after enemata and this was entirely within normal limits (Fig. 5C). The diagnosis of Hirschsprung's disease was ruled out by the roentgenologic finding of an actively contractile though very much enlarged colon. Cystometrograms have not been reported in true cases of Hirschsprung's disease, and it is therefore impossible to say whether or not cystometry would be of any value in the

diagnosis of this disease, assuming that it is due to autonomic imbalance. The study of this case has demonstrated the striking effect that influences entirely extrinsic to the bladder may exert on the cystometrogram.

The Cystometrogram after Spinal Anesthesia.—Cystometric studies were made on three patients after spinal anesthesia (75 to 100 mg. of novocain crystals in 2 cc. of spinal fluid injected in the third lumbar interspace and affording anesthesia to the level of the costal margin). Two of them were studied within one-half hour of the injection and the other 24 hours later. The cystometrograms in the first two patients were alike and of interest in two respects. The bladder capacity was strikingly reduced (120 to 140 cc.) and the spasmodic contractions of the bladder occurred in the first part of

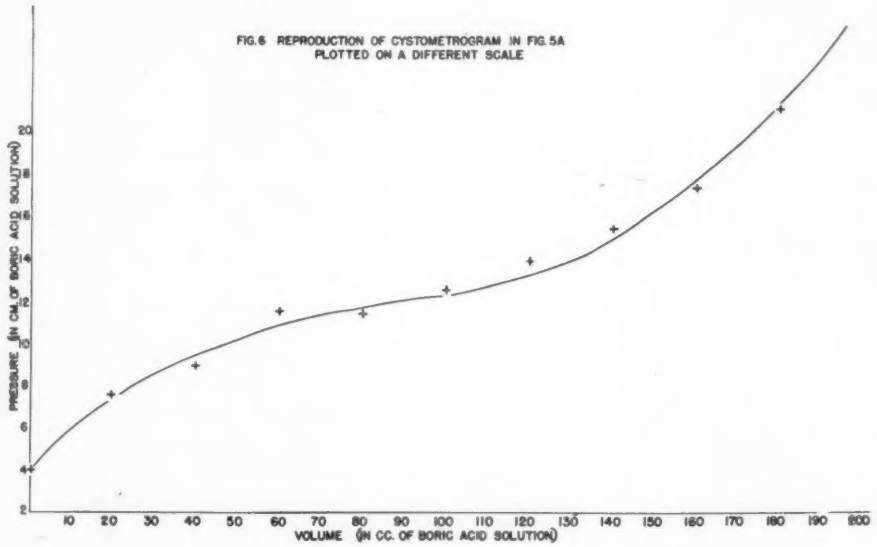


FIG. 6 REPRODUCTION OF CYSTOMETROGRAM IN FIG. 5A PLOTTED ON A DIFFERENT SCALE
PRESSURE (IN CM. OF BORIC ACID SOLUTION)
VOLUME (IN CC. OF BORIC ACID SOLUTION)

the curve and were absent from the steeply ascending part where they are found in the normal bladder. The same was found for the bladder 24 hours after spinal anesthesia, but the capacity of the bladder in this case was more nearly normal. A similar situation is reported by Langworthy, Reeves, and Tauber[5] (1934) after transection of the sacral cord in cats.

Discussion.—Mosso and Pellacani (*loc. cit.*) over 50 years ago demonstrated the important property of the urinary bladder to accommodate increasing volumes of fluid without proportionate increase in intracystic pressure. Rose[15] (1927) suggested that the peculiar behavior of the bladder is the result of the interaction of sympathetics and parasympathetics supplying the bladder. From the evidence at hand, it appears that the regulation of the intracystic pressure during filling of the bladder is a function of the sympathetic division of the autonomic nervous system. The parasympathetic division is probably more closely associated with the function of emptying the bladder. The initial rise in the cystometrograms reported above is pos-

sibly a means of evoking a stimulus of sufficient intensity to stimulate the bladder musculature reflexly through the hypogastric nerves, causing a relaxation. The final rapid rise in pressure occurs when this mechanism is no longer able to compensate for increased volumes and is an expression of the elasticity of the bladder wall itself. Langworthy, Reeves, and Tauber (1934) have shown that the urinary bladder in the cat, *after section of its sympathetic nerve supply*, loses its capacity to accommodate increasing volumes without rise in pressure. They have observed the same type of curve in the excised bladder. Potter[13] (1926) has cut the sacral nerves in dogs and has been unable to demonstrate any influence of this procedure on either bladder tone or function. The above interpretation of the cystometrogram is supported also by the observation that changes in bladder sensation are associated with changes in shape of the curve.

There is considerable evidence in the literature that the activity of the urinary bladder is ultimately under the control of the central nervous system. Langworthy and Kolb (1933 and 1935) have presented evidence for the "encephalic control" of the urinary bladder. Mosso and Pellacani (*loc. cit.*) reported changes in bladder pressure associated with cortical activity of their subjects. In the experiments reported above, it has been impossible to demonstrate any relationship between bladder activity and conscious effort on the part of the patient.

The observations on the mechanism of urgency are of interest in that they contribute to an understanding of the nature of pain arising from hollow viscera. Barney[1] (1936) has produced pain by mechanical distention of the lumen of the ureter in a patient with ureterostomy. Cunningham (1935) and Livermore (1935) suggest that the pain in ureteral and renal colic is due to increased pressure and distention in the excretory passages of the kidney. There is very good evidence, however, that the most important factor in the origin of visceral colic is the *active* contraction of the organ against obstruction. The pain from visceral irritation is probably of an entirely different nature and likewise the discomfort associated with distention of hollow viscera.

It is not the purpose of this paper to discuss at length the clinical application of the cystometer. Several papers have already been written on this aspect of cystometry and the reader is referred to these (Rose,[15] 1927, 1931 and 1932*a* and *b*; Hirsch,[3] 1938*b*; Chute,[2] 1933; and Muschat,[11] 1935*a* and *b*). The active study of cystometry in diseases of the central nervous system which is now going on in several clinics will undoubtedly make the cystometer a more and more useful instrument to the neurologist (Sachs,[16] Rose, and Kaplan, 1930; McCaughan, Major, and Braasch,[8] 1932; Watts and Uhle,[19] 1935; Langworthy and Lewis,[6] 1935; and Lewis, Langworthy, and Dees,[7] 1935). In the Urologic Clinic, the cystometer is of considerable value in differentiating functional and organic causes for such ailments as enuresis. We have been even more impressed, however, by the possible uses of the cystometer in determining the optimum time for operation after

"decompensation" of the bladder and acute urinary retention from hypertrophy of the prostate. The patient's general condition, with particular reference to hydration and renal function, is of course of prime importance. Cystometrograms made daily or every other day with the bladder on constant drainage, however, will demonstrate the gradual return of tone in the bladder musculature, and it is our impression that the optimum time for prostatic surgery, in a patient who is otherwise well prepared, is when the bladder has regained as much as possible of its normal tone.

SUMMARY.—(1) A simple cystometer is described and cystometrograms under normal and abnormal conditions are discussed.

(2) The physiology of the urinary bladder is discussed in terms of the normal cystometrogram.

(3) Observations on the nature of urgency are presented and applied to the mechanism of visceral colic in general.

(4) The use of the cystometrogram in determining a satisfactory time for prostatic surgery is mentioned.

CONCLUSIONS

(1) The normal cystometrogram is divisible into three parts: (a) An initial rise; (b) a flat region; and (c) a final steep rise.

(2) Bladder sensations are associated with changes in shape of the cystometric curve, and urgency appears with bladder contractions during the third portion of the curve.

(3) Urgency, and probably visceral colic in general, is the subjective experience associated with the active attempt of an organ to empty against resistance.

(4) The time for prostatic surgery for acute retention from prostatic obstruction may well be guided by the return of bladder tone toward normal, as reflected in the cystometrogram.

The author wishes to thank Dr. J. Dellinger Barney for his encouragement throughout the course of this work.

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HUMAN BITE INFECTIONS OF THE HAND*

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IN JANUARY, 1935, due to the frequency of crippling deformities following human bite infections of the hand, it was decided to make a special study of these injuries at Bellevue Hospital. Through the courtesy of the directors of the four surgical services at the hospital, all such cases admitted were referred to the Fourth Surgical Service for study.

These injuries are by no means uncommon. In the course of one year (January 1, 1935–January 1, 1936) 27 cases of human bite infections were admitted to the service. This report, however, is concerned with only those injuries involving the hand, which totaled 17. In most instances, the injury was sustained in a fist fight and a laceration was produced over one of the knuckles of the hand. Four of our cases were in nurses who had been bitten by psychopathic patients and three were in police officers who received their injuries while trying to subdue a prisoner.

The location of the majority of the injuries in this series was quite naturally on the back of the hand, usually over one of the knuckles. We did, however, have several patients who were bitten on the cheeks, lips and ears. These latter cases recovered quite promptly without complications with conservative treatment, that is, by thorough cleansing of the wound, cauterization and wet dressings. It seemed to us from this observation, that the complications in the hand injuries must be due to an injury to some moving underlying structure, such as a tendon or joint.

In considering the treatment of this type of hand infection, it is important to remember that in the great majority of these cases, when the laceration over the knuckle is sustained, the fist is clenched. In this position the extensor tendons of the fingers are stretched over the knuckle. Following the impact, the fist relaxes and the uninjured extensor tendon, instead of lying directly under the laceration in the skin, now slides back as much as one-half to three-quarters of an inch. Consequently, any local treatment applied to the laceration has no effect whatever upon the injured tendon. The skin injury may be effectively treated by various agents but the tendon injury is well concealed and these agents are ineffectual. This fact, we believe, accounts for many of the disastrous results encountered in these infections. Any treatment, therefore, to be effective, must take into account the possibility of this retraction of the tendon. Several cases were observed in this series in which the skin wound was cauterized immediately following the injury and the patient and physician felt secure, only to find that the infection continued to spread and radical procedures

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were necessitated, but it was then usually too late. The results obtained in these cases are directly proportional to the time elapsing between the receipt of the injury and the institution of adequate treatment. It is safer to suspect most knuckle lacerations as being due to human bites until proved otherwise. In several of our cases the patient falsified the history to avoid giving the true cause of the injury until the infection had spread and the condition had become alarming. In those patients who reported for treatment immediately following the injury, the results were uniformly good.

A culture was taken from every wound at the time of operation. Both aerobic and anaerobic cultures were made. From the majority of the wounds a mixed culture was obtained. The offending organisms were both aerobic and anaerobic with the Vincent organism predominating.

Meleney's employment of zinc peroxide on aerobic and anaerobic infections of another type suggested the possible value of this chemical in these infections. Consequently, zinc peroxide was used on the first six cases as an adjuvant to adequate surgical drainage. These patients did quite well, but in the succeeding cases the zinc peroxide was discontinued chiefly because of the difficulty at the time of getting a standardized active product. Theoretically, zinc peroxide should have been an ideal substance to use in these cases because of its property of giving off oxygen slowly over a long period of time. Owing to the uncertainty of action of that available at the time and the equally good results obtained by thorough débridement of the wound with local application of salvarsan, it was discontinued in the remainder of the cases.

It is true that many of these cases in which only the skin is broken with no injury to the underlying tendon or joint will recover without any complications with simple cauterization and wet dressings. The difficulty is in determining which cases these are. It is most essential therefore to determine immediately the depth of the laceration and decide whether or not the underlying tendon or joint has been involved in any way. The depth of the laceration as ascertained by careful probing is the best guide. If any doubt remains after careful examination and probing, the safest procedure, we feel, is thorough débridement and treatment as outlined below.

The course of the infection in these cases is quite uniform. On the dorsal surface the metacarpophalangeal joints have little protection from injury other than the skin and overlying extensor tendon and joint capsule. The extensor tendon over the knuckle spreads out to form a membranous expansion over the knuckle and is closely associated with the capsule of the joint. The extensor tendons of the hand have no definite tendon sheaths as do the flexor tendons. Consequently, any forceful blow over the knuckle which causes a break in the skin is quite likely to affect the underlying tendon and joint capsule. If the joint capsule should remain intact and only the tendon is injured, the infection will extend proximally along the course of the tendon resulting in an ascending infection on the dorsal surface of the hand with sloughing of the tendons. If both tendon and joint

capsule are involved in addition to the above extension, the metacarpophalangeal point may become infected and point in the palm and involve the flexor tendons. Several cases in this series illustrate the above possibilities.

Treatment.—The treatment we have found most effective in this type of injury is as follows: A thorough débridement of the injured area is performed using an Esmarch bandage. A careful examination of the underlying tendon is made for any evidence of injury or infection. We feel it is essential to débride well beyond all evidence of injury or infection, making sure no overhanging edges or pockets are left in the wound. All tissue that is even suggestive of infection is removed. If there is any evidence of extension into the palm, this should be opened widely at this time. Salvarsan is then applied to the wound, which is then packed with either plain or iodoform gauze. Salvarsan is applied daily for two or three days. At each dressing, the wound is thoroughly irrigated with hydrogen peroxide. The dressing is kept wet with either a boric acid or a magnesium sulphate solution.

This wide débridement of a small laceration may seem radical but the operative wound heals rapidly and causes the patient but slight discomfort or subsequent disability. It must be remembered that every bite does not require this radical treatment. A careful evaluation of the depth of the laceration and injury to the underlying structures is necessary before any treatment is instituted. It is better to err on the side of radicalism than to be conservative and allow the infection to gain headway and risk the danger of an amputation and unnecessary long period of disability.

The necessity for prompt treatment is clearly shown in our series of cases. Delay, however, in instituting adequate treatment is not always the fault of the patient. Several of our cases had, indeed, been treated immediately after the injury was sustained, at which time either a wet dressing was applied or the wound cauterized, and on return in a day or two, it was found that the infection had spread, necessitating operative treatment, and not infrequently amputation resulted. In three cases the wound had been sutured primarily. Needless to say, the results in these cases were disastrous.

If after carefully examining the patient, conservative treatment is decided upon, that patient should be watched carefully for the first 24 hours. It is not enough to apply a wet dressing and tell the patient to return the next day. He must be continuously observed. If the infection is going to spread, it will be evidenced within the first 24 hours, and that is the time to institute radical treatment. Table I summarizes the cases in our series upon which this report is based.

It will be seen readily from Table I that those cases immediately seen and given adequate treatment made a rapid and complete recovery with no complications. Those cases in which treatment was delayed were confined to the hospital for a longer period of time and in most cases resulted in amputation of a finger or some other deformity.

TABLE I

SUMMARY OF 17 CASES OF HUMAN BITES OF THE HAND

Case	Sex	Age	Location	Date of Injury	First Treatment	Adm. to Hospital	Condition on Admission	Treatment	Date of Discharge	End-result
1	M.	35	Rt. 2nd knuckle	1/14/35	1/17/35	1/17/35	Swelling dorsum and severe severe pain	Wide incision. ZnO_2	2/ 1/35	Completely healed. No loss of motion
2	M.	21	Rt. index finger	2/ 4/35	2/ 4/35	Not adm.	Small superficial laceration	Cleaned. ZnO_2	2/ 5/35	Healed primarily—2/6/35
3	M.	32	Rt. 2nd knuckle	3/ 2/35	3/ 4/35	3/ 4/35	Marked swelling dorsum—midpalm pain	Wide excision. ZnO_2—3/4/35	3/13/35	Completely healed. No loss of function. Suicide 4/10/35
4	M.	19	Rt. 2nd knuckle	3/20/35	3/21/35	3/21/35	Extreme pain and swelling dorsum	Palmar space opened. ZnO_2 3/7/35	3/25/35 A.O.R.	Practically healed. No function—3/29/35
5	M.	22	Tip of little finger	3/27/35	3/27/35 HNO_3 in O.P.D.	Not adm.	Pain entire finger; superficial laceration	No operation. ZnO_2	4/ 1/35	Cured
6	M.	40	Index finger	3/14/35	3/19/35 L.M.D. Wet dress.	3/21/35 2nd Div. to 4th. 3/30/35	Sloughing finger palmar extension	Amp. of finger 4/1/35	4/ 9/35	Loss of finger
7	M.	36	Lft. 2nd knuckle	4/26/35	4/30/35	4/30/35	Extension to palm and whole of dorsum	Wide excision palmar incision. Salvarsan	5/10/35	No loss of function
8	M.	28	Rt. 2nd knuckle	5/ 8/35	5/ 9/35	5/ 9/35	Pain and swelling dorsum	Excision. Salvarsan	5/14/35	No loss of function
9	M.	16	Rt. 3rd knuckle	5/12/35	5/13/35	5/13/35	Pain and swelling dorsum	Excision. Salvarsan	5/16/35	Uneventful recovery
10	F.	40	Rt. thumb	5/ 9/35	5/10/35 Harlem O.P.D.	5/15/35	Whole thumb infected—extension to wrist	Several opers. on forearm and thorough drainage. Amp. of thumb	7/14/35	Loss of thumb
11	M.	18	Rt. hand, dorsum 1st knuckle	5/15/35	5/16/35	5/16/35	Pain and swelling dorsum —no extension to palm	Wide incision. Salvarsan	5/24/35	No loss of function
12	M.	24	Index finger	6/14/35	6/14/35	6/14/35	Pain—very little swelling	Excision. Salvarsan 6/14/35	6/25/35	No loss of function
13	F.	28	Rt. index finger	11/10/35	11/12/35	11/12/35	Marked pain and swelling	Incision and drainage. Salvarsan. Amp. of finger	11/24/35	Amputation of finger
14	F.	30	Rt. 3rd finger	12/16/35	12/20/35	12/20/35	Extensive infection	Amp. of finger	1/ 2/36	Amputation of finger
15	F.	24	Rt. thumb	12/17/35	12/19/35	12/19/35	Pain and swelling	Excision. Salvarsan	12/28/35	No loss of function
16	M.	14	Lft. index finger	3/22/36	3/24/36	3/24/36	Pain and swelling	Excision. Salvarsan	3/27/36	No loss of function
17	M.	22	Rt. 3rd knuckle	6/12/36	6/14/36	6/14/36	Pain and swelling	Excision. Salvarsan	6/22/36	No loss of function

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CONCLUSIONS

(1) Human bite infections of the hand are not uncommon and are of a serious nature.

(2) Prompt and adequate treatment is necessary to prevent crippling deformities.

(3) Thorough débridement and salvarsan locally have given the best results.

I wish to express my appreciation to Drs. Carl G. Burdick, John Alexander McCreery, Guilford Dudley, and Arthur Wright, directors of the Fourth, First, Second, and Third Surgical Divisions of Bellevue Hospital, respectively, for their courtesy and coöperation in making this report possible.

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NARROWING OF THE INTERVERTEBRAL FORAMINA AS A CAUSE OF PSEUDORHEUMATIC PAIN

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DURING the last two years, 72 patients have been referred to this department for roentgenologic examination because of pain in the shoulder, the tentative diagnosis being arthritis or rheumatism. Arthritis of the shoulder was found in one case, a cervical rib in three, and narrowing of cervical intervertebral foramina in 66; in two cases, the roentgenologic findings were negative.

This observation shows, first: That compression of nerve roots as a consequence of some spinal lesion is a common cause of pain and discomfort; and, second: That the clinical findings in these conditions are often so misleading that the neurogenous nature of the symptoms is hardly recognizable.[29] It seems justifiable, therefore, to present some new observations concerning the differentiation and treatment of those chronic spinal diseases which, by involvement of the intervertebral foramina, give rise to segmental neuritis.

Roentgenologic Findings.—Compression of nerve roots may occur within either the spinal canal or the intervertebral foramina. Among the pathologic processes here discussed, two are known to cause compression within the canal: (1) After traumatic rupture or degenerative softening of the annulus fibrosus, the posterior part of the intervertebral disk may be displaced backward and thus bulge into the spinal canal (Williams and Yglesias,[32] Alajounine and Petit-Dutaillis,[1] Mixter and Ayer,[21] Glorieux' "Hernie nucléaire postérieure intrarachidienne"[13]); or a piece of cartilage detached from the injured disk (Dandy[10]), or a calcified Schmorl's nodule (Werthman and Rintelen[30]) may likewise cause pressure upon the cord. (2) Inflammatory swelling of periarticular tissues (Nathan[23]) followed by exostotic formations bulging into the spinal canal (Bailey and Casamajor,[4] Parker and Adson[26]) may produce signs of compression. Owing to the localization and the size of the area thus affected, the clinical findings, in these cases, suggest a lesion of the cord rather than of individual nerve roots. Neither prolapse of the disk nor the inflammatory processes above mentioned are revealed by direct roentgenologic evidence. Indirectly, prolapse of the disk may be assumed in the presence of a rounded defect within a myelographic filling when associated with a reduced intervertebral space at the same level (Mixter and Ayer, Glorieux). The inflammatory lesions alluded to do not produce typical roentgenologic findings.

Characteristic roentgenologic findings, however, are demonstrable in the

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case of pressure upon nerve roots resulting from those diseases which affect the intervertebral foramina. The technical details of the method are given in a separate paper.[25] Calvé and Galland,[7] Dansforth and Wilson,[11] Williams,[31] Williams and Yglesias,[32] Ayer,[3] Hadley,[15] Oppenheimer and Turner,[24] and others, have shown that acute or gradual thinning of the disk will affect both the height of the intervertebral foramen and the position of the articular processes. As the space between the vertebrae diminishes in proportion to the degree of thinning of the disk (Fig. 1), the decrease in height of the foramen is obviously due to the narrowing of the interspace, while the resulting forward displacement of the superior articular process of the subjacent vertebra produces a decrease in the lateral diameter. The considerable narrowing of the foramen thus caused (Fig. 2B) is quite sufficient to account

FIG. 1.—Cervical spine, lateral views. (A) Early discogenetic disease: Thinning of only one disk, consecutive displacement of the superjacent vertebra. Note the absence of any exostotic deformities. (B) Advanced discogenetic disease: Thinning of all the disks, very marked exostotic deformities limited to the vertebral bodies; the apophyseal joint spaces are wide; the articular processes free of any similar exostoses. (C) Spondylarthritis: Apophyseal joint spaces greatly narrowed, blurred (white arrows); longitudinal ligaments calcified (black arrows); disks not involved.

for marked compression of nerve roots; hence it is unnecessary to assume, under these conditions, some additional inflammatory reaction of soft tissues —which, by the way, has never been observed at operation or autopsy.

Some secondary changes, however, may complicate the picture. The displacement of the articular processes, for instance, sometimes amounts to actual contact of the bones, to impingement of the tip of the subjacent process against the superjacent pedicle (Hadley[15]), and even to penetration of a displaced articular process into the adjoining vertebra (Fig. 3). This may lead to intense bony reactions, shown by marked eburnation and exostotic excrescences. Small exostoses on the posterior margins of the vertebral bodies are often seen in oblique views (Fig. 2B) and may increase the compression already present. Almost invariably associated with larger exostoses at the anterior and lateral borders of the vertebral bodies involved (Fig. 1B),

these changes are not due to primary arthritis, but to reactions consequent upon the mechanical irritation resulting from loss of the disk, as demonstrated, in the case of the vertebral bodies, by the experiments of Keyes and

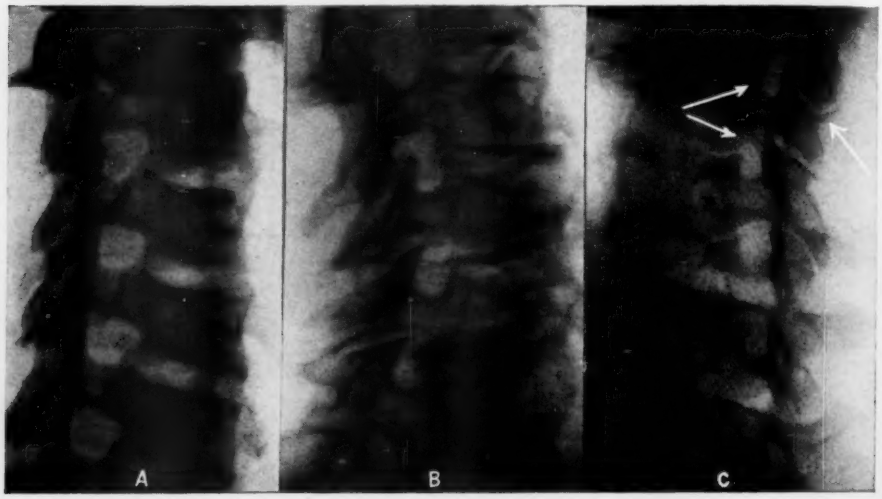

FIG. 2.—Cervical spine, oblique views. (A) Normal foramina. (B) Discogenetic disease: Anterior subluxation of inferior articular processes causing narrowing of foramina; exostoses at the posterior margins of the bodies; apophyseal joints free. (C) Spondylarthritis: Constriction by arthritic deformities (one arrow) and calcification of ligamenta flava (two arrows).

Compere.[19] As it is primarily the morbid condition of the disk which initiates all the changes now under discussion, the term "discogenetic disease," suggested in a previous report,[24] is adopted in this article. Among the various

FIG. 3.—Unilateral (left) penetration of inferior articular process into superjacent vertebra; disks greatly thinned. Extensive bony reaction.

processes that induce hypertrophic deformities of the spine, the importance of this common disease has not yet been sufficiently appreciated.

The roentgenologic findings are quite definite in advanced cases, where the

thinning of the disk results in marked narrowing of the intervertebral space. Williams and Yglesias[32] have pointed out that the disk may be thinned only in its posterior portion, whereby, in the lateral view, only the posterior part of the interspace appears narrowed. Another condition, which we have not found mentioned in the literature, consists in unilateral thinning, either left or right, of the disk, resulting in a strictly unilateral neuritis (Fig. 4). Clinical observations make it probable that this unilateral thinning is common; for, generally speaking and for a long time, the symptoms are limited to one side; but, with the progress of the disease, the whole of the disk collapses, thereby causing a shifting of the pain to the other side, and resulting finally in bilateral paresis of certain groups of muscles.

Narrowing of an intervertebral foramen may be produced also by a particular lesion hitherto undescribed. In this condition, there is no sign of

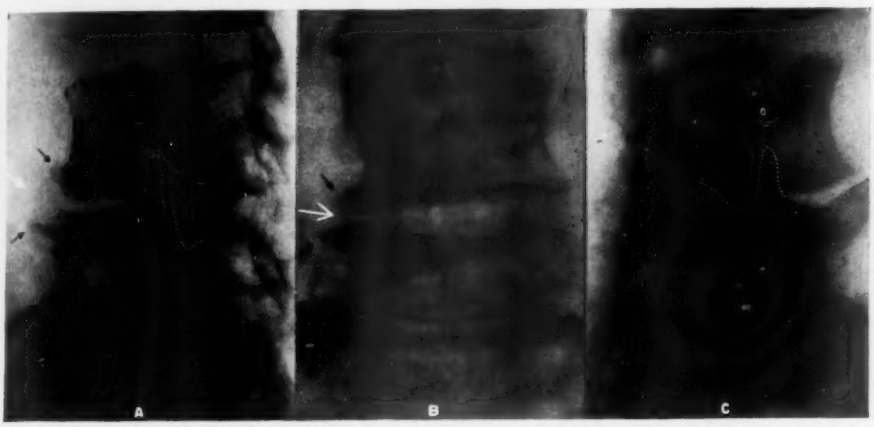

FIG. 4.—Unilateral thinning (right) of fourth lumbar disk; obliteration of lumbosacral space. Note that exostoses are limited to the side narrowed (arrows). Bony contact between articular processes in (A), as compared with normal position on the left side (C).

involvement of the disks. In four cases of severe radiculitis, we have observed, in one inferior articular process, circumscribed defects produced by a kind of bore-hole drilled, as it were, by the superjacent articular process into the facet (Fig. 6). This results in narrowing of the posterior part of the foramen. The articular process is decreased in height and its bony structure appears less regular than that of the neighboring bones. In three cases, it was the sixth cervical vertebra which showed these changes; in one, the seventh cervical. Even in normal spines, the inferior articular processes of these vertebrae are often found thinner than those of the adjacent vertebrae. The angulation at the junction of cervical and dorsal spine also causes these articular processes to approach each other closely, especially during posterior stretching of the neck. It is conceivable, therefore, that the increased mechanical stress at this level is equivalent to the kind of trauma known to facilitate, in other bones, the localization of an infection (*e.g.*, tuberculosis or osteomyelitis). In two cases, pulmonary tuberculosis was found on both clinical and roentgenologic examination.

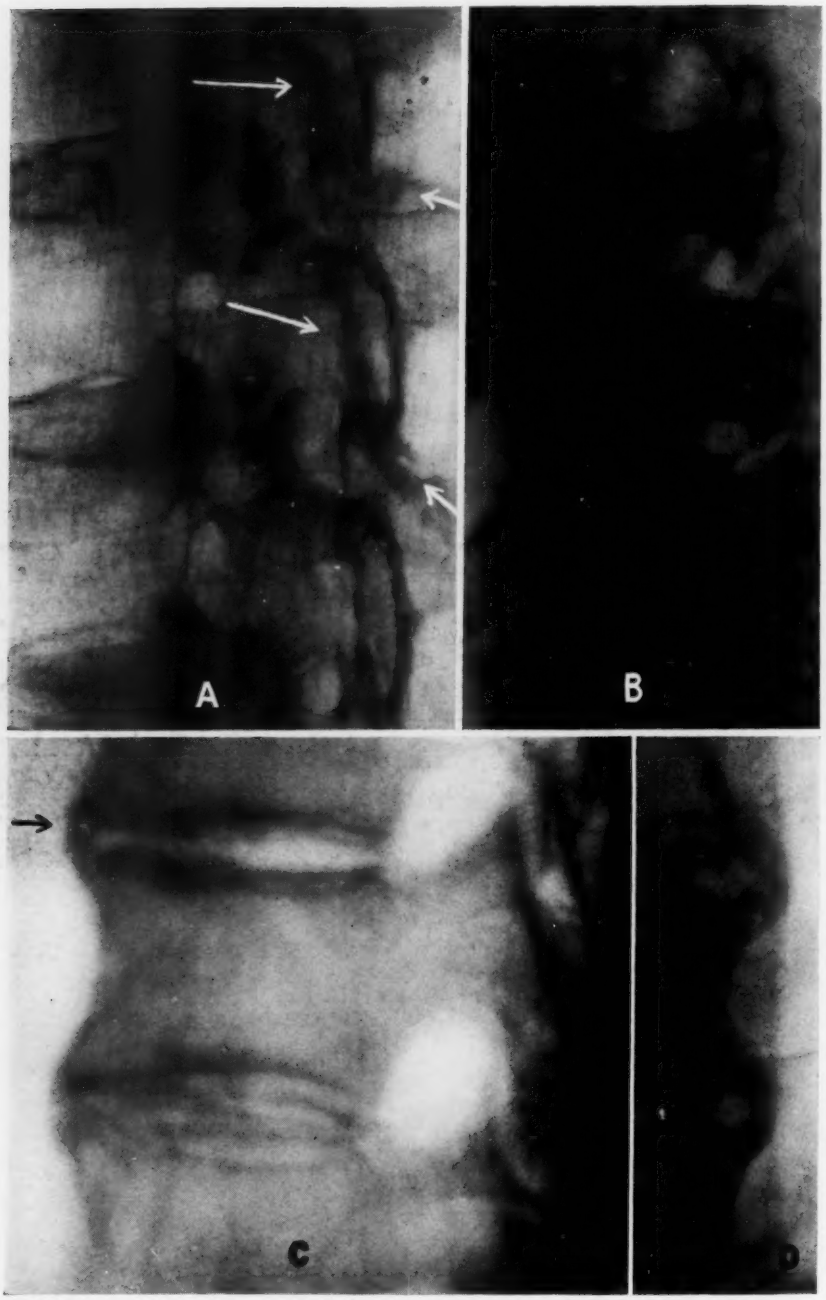

FIG. 5.—Ankylopoietic spondylarthritis. (A) Ankylosis and arthritic deformities of the dorsal apophyseal joints. (B) Normal dorsal joints. Compare the width of the joint spaces. (C) Calcification of anterior, and (D) of lateral longitudinal ligaments.

The production of neuritic symptoms by destructive lesions (Pott's tumors) and by changes in the relative position of certain vertebrae, as in spondylolisthesis and allied conditions, is well known. In the pathologic conditions thus far mentioned, narrowing or deformation of the foramina is consequent upon some decrease in size, hardness or elasticity of those tissues which normally hold in place the bones encircling the foramen. A different mechanism of constriction occurs in primary arthritis of the apophyseal joints. The term arthritis is here used in its original signification, namely, to designate inflammation of a joint. As emphasized in a previous report,[24] only the apophyseal articulations are true joints, whereas the space between the bodies (centra) of adjacent vertebrae has nothing of the anatomic structure characteristic of an articular space. Considerable confusion has arisen from the fact that this intervertebral structure, which is essentially a synchondrosis, has often been called an intervertebral joint, and the pathologic conditions affecting it described as "arthritic." The term arthritis of the spine, or spondylarthritis, should apply only to diseases originating in the articulations (namely, the joints formed by the articular processes), whereas calcifications, exostoses and deformities involving the intervertebral spaces should be called hypertrophic spondylitis, or, according to Schmorl's fundamental work, deforming spondylosis, and not spondylarthritis. Roentgenologically, a distinction between "arthrosis," a degenerative lesion, and "arthritis," an inflammatory one, is not yet possible. In order to avoid adding to an already overloaded terminology, only the term spondylarthritis is here used. It is true that spondylarthritis is associated occasionally with deforming spondylosis; but, nevertheless, each of these diseases is a distinct and definitely characterized entity.

FIG. 6.—Rarefaction in the sixth cervical inferior articular process, with penetration of the superjacent process into it.

It is important to remember that spondylarthritis is primarily a disease (rheumatoid arthritis) of the synovial membranes of the apophyseal joints (E. Fraenkel,[12] recently confirmed by Guentz[14] and others). In incipient stages, swelling of soft tissues may have already caused pressure upon nerve roots (Nathan[23]). Roentgenologically, mottled demineralization of the articular processes is the first reliable sign. Haziness of the joint space may also be noticeable; roughening of the articular surfaces follows. Eventually, calcification of the capsule and ligaments, often associated with bony ankylosis of the facets, immobilizes the segment involved; hence the term "spondylar-

thritis ankylopoietica" (Figs. 1C, 2C and 5). The process may then spread to the costotransversal joints and to the longitudinal ligaments which connect the vertebral bodies, whereby, in case of calcification of the latter, ossified fusion occurs of the whole spine or of parts of it (Bechterew type). The disease, which may become arrested at any stage, may affect the whole spine or one segment only; it may even be limited to part of a joint, such as the ligamentum flavum (Bakke[5]). Arthritis of the shoulders or the hips is sometimes superadded (Pierre-Marie-Struempell type). According to the literature on the subject, arthritis of the ileosacral joints, followed by ankylosis, is very commonly the first manifestation of "ankylopoietic spondylarthritis." In our own observations, however, arthritis and bony ankylosis of the lower dorsal apophyseal and costotransversal joints precede, often for several years, the involvement of the ileosacral region. This difference of opinion represents merely a difference in conception of the term "ankylopoietic." In the past, the diagnosis has mainly been based upon bony fusion of the vertebral bodies ("bamboo-spine"), which is characteristic of advanced stages commonly associated with ankylosis of other, *e.g.*, the ileosacral, joints. In our method, earlier changes, such as ankylosis of only a few facets, are made visible long before the ossifications leading to "bamboo-spine" occur. According to the results obtained by this method, we may state that, in the majority of cases, ankylosing arthritis involves the apophyseal joints first, and that only on rare occasions does ileosacral arthritis precede these changes. Hence, in radiculitis suggestive of a spinal lesion, it is imperative to examine the apophyseal articulations even in the absence of ileosacral changes—a conclusion of obvious practical importance.

The intervertebral disks are never primarily involved; only in advanced stages do they appear compressed, as it were, by the calcifications that surround them. Even in terminal stages, the roentgenologic aspect of an ankylosed spondylarthritic column ("bamboo-spine") is distinctly different from the appearance produced by exostotic fusions resulting from deforming spondylosis as first shown by Assmann.[2] Compression of nerve roots may occur at any stage of the disease, either by inflammatory swelling or by secondary calcifications, *e. g.*, those arthritic deformities of the facets and calcifications which concentrically involve the posterior margin formed by the longitudinal ligaments. In other cases, only parts of the circumference appear deformed by ossifications. As a rule, the narrowing of the foramen produced by this process is less marked and more irregular than the narrowing found in discogenetic disease. The roentgenologic diagnosis of spondylarthritic constriction, unless proved by extensive calcifications of the longitudinal ligaments, must be based upon ankylosis of the facets and ossification of periarticular tissues combined with absence of any subluxation of the facets and of a reduced intervertebral space—in other words, in the absence of signs suggestive of lesions of the disk. Except in a few border-line cases, these criteria will suffice to differentiate between primary spondylarthritic and so called arthritic changes consequent upon discogenetic diseases.

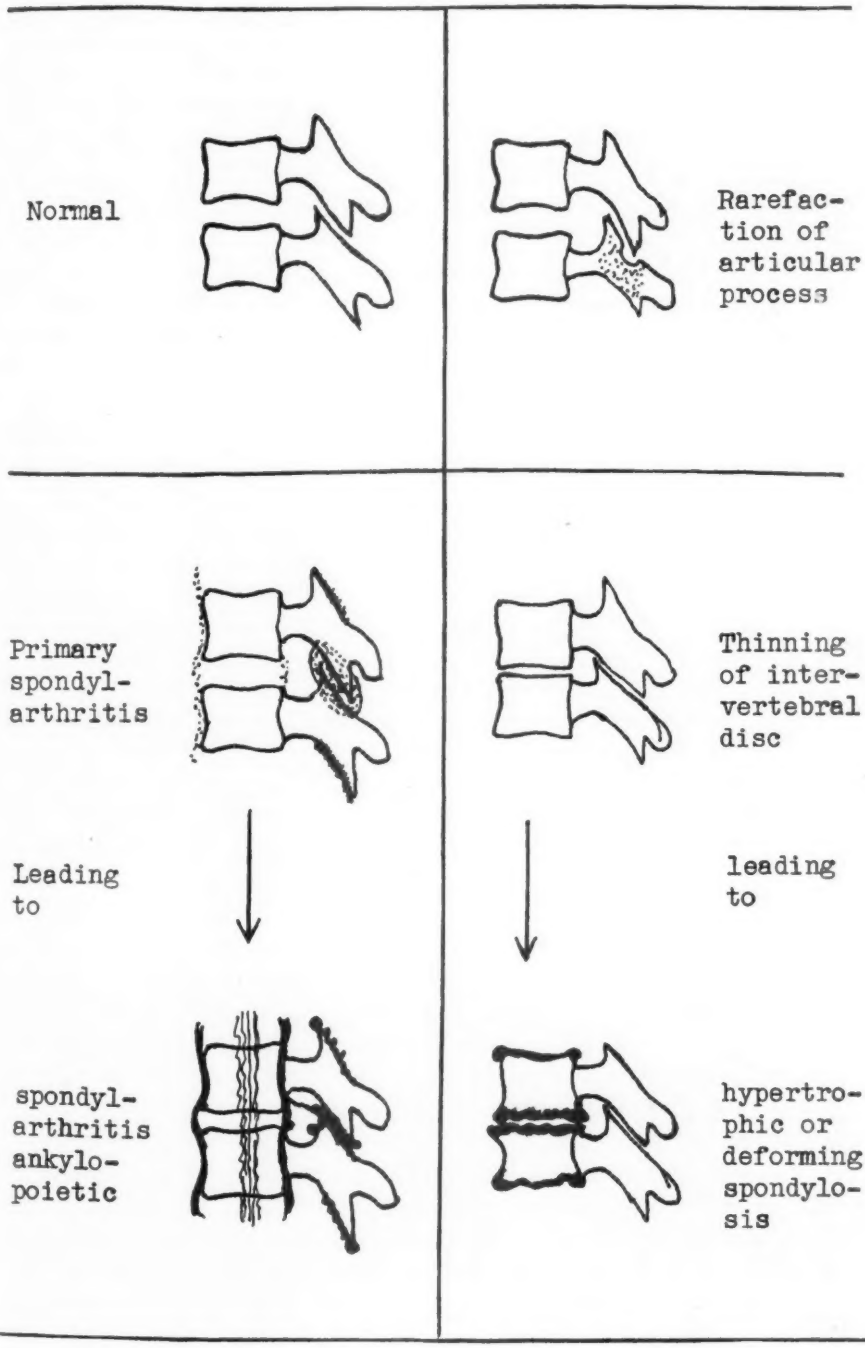

FIG. 7.—Mechanisms of narrowing.

Clinical Findings.—Regardless of the underlying pathologic process, narrowing of intervertebral foramina, as soon as it attains a sufficient degree, will produce pressure upon nerve roots. This syndrome has been called neurodocitis by Putti,[27] in 1927; the term is derived from neurodokon, *i.e.*, the bony channel through which nerves pass. While the roentgenologic signs in the great majority of cases are quite evident, the clinical symptoms and signs are exceedingly variable and very often not suggestive of a nerve lesion. Recurrent lumbago, vague pains in the chest, "rheumatism" of the shoulder are the first symptoms, often too slight and indefinite to make the patient seek medical advice. Because of the complete absence of signs typical of a neurogenous lesion, these complaints are usually attributed to myalgia or incipient arthritis. Gradually, in the course of many years, the symptoms become more persistent, until at last either paresthesia or atrophy of a group of muscles proves the involvement of nerves. In those moderately advanced cases that are seen by the physician, persistent sciatic pain, or low backache, is probably the commonest symptom. In the upper extremities, increasing interference with certain movements indicates the progress of the disease: a woman complains of discomfort felt in combing her hair, fastening her dress at the back, or lifting a pan; a man feels pain when putting on his coat, or carving meat, or raising his hat. Occasionally one finds a syndrome, first observed by Nachlass,[22] of pseudo-angina pectoris produced by constriction of lower cervical foramina. In pains in the procordium associated with discomfort in the left shoulder in a person above 50 years of age, it is rather difficult to convince the patient and the attending physician of the spinal origin of the symptoms.[29]

Although the diagnosis depends eventually upon the roentgenologic appearances, a number of clinical symptoms and signs have been found helpful for the differentiation of the underlying processes. The data analyzed in Table I are based upon 270 observations made during the last two years; they are, of course, no more than average figures subject to all the limitations inherent in clinical statistics.

Summing up the results of these clinical observations, we may state that the symptoms in discogenetic disease begin at the periphery, while pain and stiffness in the spine itself are the first symptoms noticed in spondylarthritis, and usually precede definitely the pains felt in the course of the nerves. This difference is probably due to the fact that diseases of the disk itself are not felt unless they lead to secondary compression, as the disk and its envelopes are devoid of nerves (Jung and Brunschwig[18]); whereas in spondylarthritis the inflammatory swelling itself obviously produces pain before the nerve roots undergo compression. The recumbent position and rest in bed conduce definitely to relief in spondylarthritis; but in discogenetic compression, patients commonly complain that their discomfort is elicited by rest and recumbency, and emphasize the fact that the pain prevents them from sleeping comfortably. Furthermore, whereas almost any motion, active or passive, causes pain in spondylarthritis, it is especially the movement involved in

TABLE I

SYNOPTIC DATA OF CLINICAL SYMPTOMS AND SIGNS

Nature of the Data Recorded	Segmental Neuritis in Discogenetic Disease	Segmental Neuritis in Spondylarthritis	Segmental Neuritis in Atrophy of One Articular Process
Number of observations:	Cervical I–III*... 2 Cervical IV–VII.. 56 Dorsal I–X..... 0 Dorsolumbar..... 31 Lumbar II–IV... 32 Lumbosacral.....122 Systemic..... 0 Total.....243	Cervical I–III.... 4 Cervical IV–VII.. 4 Dorsal I–X..... 6 Dorsolumbar..... 5 Lumbar II–IV... 1 Lumbosacral..... 2 Systemic..... 4 Total..... 26	Cervical I–III.... 0 Cervical IV–VII.. 4 Dorsal I–X..... 0 Dorsolumbar..... 0 Lumbar II–IV... 0 Lumbosacral..... 0 Systemic..... 0 Total..... 4
Age at which first symptoms occur:	30 to 40 years.	Any age including adolescence	Unknown
Age at which definite neuritis becomes evident:	Around 50 years	Variable	Unknown
Number of foramina involved:	1 to 3 per segment	Any number	One
Spontaneous pain in the spine itself:	Common in the lumbar, very rare in other segments	Common	Common
Tendernesson pressure upon the spinal segment involved:	Common	Variable; positive in early, often negative in advanced stages	Variable
Timeofappearance of the pain:	Invariably the first symptom noticed	A late symptom	Early?
Restriction of mobility in the spine:	Common in the lumbar, rare in the cervical spine	Constant and pathognomonic	Absent
Sensation of stiffness in the spine:	Variable	Constant	Variable
Pains aggravated by:	Backward extension, dorsal recumbency (rest at night), walking, moving	Bending forward, rotation, erect position, backward stretching	Not examined
Pains relieved or diminished by:	Bending forward	Recumbent position (rest at night)	Not examined
Etiology:	Traumatic, degenerative or senile	Inflammatory, bacterial	Tuberculosis? A typical rheumatoid spondyl arthritis?

* The Roman numerals refer to the foramina involved: *e.g.*, Cervical VII means the foramen between the seventh cervical and the first dorsal vertebrae.

drawing the spine backward, as in lifting an object from the floor, which aggravates the discomfort in discogenetic disease. On the other hand, as a general rule, bending forward relieves the pain, owing to the fact that the lordotic position narrows the foramina, while the kyphotic position widens them (Brown[6]). In spondylarthritic ankylosis of the articular processes, the width of the foramen is not affected by any motion; hence, no movement of any kind affords relief. Before bony ankylosis takes place, bending forward may decrease the pressure upon the affected nerve and thus give some relief in either disease.

As mentioned above, the constriction of the foramina is in general less pronounced in spondylarthritis than in discogenetic disease; hence, segmental neuritis is more common in the latter. Moreover, spondylarthritis is a rare

lesion, while discogenetic disease is common. As for the few observations recorded concerning the peculiar condition associated with atrophy of a cervical articular process, the data are not numerous enough to allow of classification.

Therapy.—Long continued compression leads eventually to irreparable degeneration of parts of the nerve; accordingly, the treatment of the diseases under discussion is based primarily upon early recognition of the neurogenous origin of many "rheumatic" or "arthritic" symptoms. Relief from compression by operative grafting is well known to produce most satisfactory results in discogenetic disease of the lumbosacral junction. In cervical segmental neuritis, head traction has been advocated by Nachlass[22] and by Hanflig;[16] Turner and Oppenheimer[29] have also observed definite improvement after manual or mechanical traction in discogenetic disease of the cervical spine.

In spondylarthritic compression, traction has not given satisfactory results; in some instances, even aggravation of the symptoms has been observed by the present writer. Among the patients suffering from spondylarthritis referred to in Table I, only five have undergone treatment in our hospital services; all of them acknowledge definite improvement following upon a series of six to 12 ultrashort-wave treatments.

In three patients, focal infection was assumed to be the cause of spondylarthritis. The first, a male student, age 24, had been suffering from severe left sciatica for 11 months before he was referred to us. There was marked atrophy of the muscles and diminution of the reflexes of the left leg; the pains subsided only when the patient was at rest in bed; they had not responded to any of the modes of treatment employed, including vaccination, shock-therapy, all sorts of analgesics, salicylates, and roentgen irradiation. Even morphine gave only slight relief. Definite roughening of the articular surfaces of the left fourth and fifth lumbar apophyseal facets was found roentgenologically (11 months after beginning of the symptoms); the intervertebral spaces were perfectly normal. A focus of infection was therefore sought for; the tonsils, although not enlarged, emitted a few drops of greenish pus on pressure. Three days after tonsillectomy, the symptoms subsided entirely, and the patient is now cured. The second patient, a physician, age 37, was relieved after extraction of an infected tooth, of all the symptoms resulting from a similar condition of the upper dorsal segments. The third, an engineer, age 29, had been suffering for five months from severe precordial pain which occurred almost daily during his work. Physical, roentgenologic, and all kinds of laboratory examinations did not reveal any lesion of heart and aorta. There was a moderate tenderness of the lower cervical spine, but the patient had never felt spontaneous pain or any discomfort in the neck. Percussion of the spinous process of the seventh cervical vertebra elicited a severe attack of precordial pain similar to those stated in the history. On roentgenoligic examination, very marked demineralization of the sixth and seventh cervical articular processes was then found. After treatment of an alveolar pyorrhea and of two infected molar roots, the patient was cured.

These observations correspond to the results of investigations showing the rôle of focal infection in the production of rheumatoid arthritis. They seem to us to add some clinical evidence to the histologic and roentgenologic findings already mentined, which demonstrate that spondylarthritis is an inflammatory disease, probably of bacterial origin.

In a few cases of discogenetic disease, severe symptoms of recurrent radiculitis, lasting for ten years and more, subsided gradually in the course of a year without any therapy. In these patients, extensive exostoses are found, connecting the anterior and lateral borders of the vertebral bodies involved, and thus immobilizing the diseased area. It is possible that this bony fusion prevents the additional compression caused by certain physiologic movements. The mobility of the spine as a whole is not diminished, as sufficient mobility remains in adjacent segments.

SUMMARY

(1) In a large number of patients suffering from pain and discomfort suggestive of rheumatism or arthritis, segmental neuritis, resulting from compression of nerve roots, has been shown to be the cause of the symptoms.

(2) This compression is due chiefly to narrowing of intervertebral foramina caused by:

(*a*) Discogenetic disease, marked by collapse of foramina and subluxation of articular processes consequent upon thinning of intervertebral disks. Roentgenologic signs are: Subluxation of the said processes, narrowing of intervertebral spaces. Main clinical symptoms are: Discomfort, slight in the spine, severe in the periphery, aggravated at night.

(*b*) Inflammatory swelling, followed by ankylosis of the apophyseal joints in the course of primary spondylarthritis. Roentgenologic signs are: Ankylosis and deformities of the articular processes in the presence of normal intervertebral spaces. Clinical signs are: Symptoms beginning in the spine itself; stiffness of the spine; relief at night.

(*c*) Penetration of an articular process into a diseased subjacent process in the presence of normal disks and normal apophyseal joint spaces.

(3) The treatment varies with the mechanism of constriction: Mechanical widening of the foramina is indicated in discogenetic disease, and anti-inflammatory therapy in spondylarthritis.

(4) Observations concerning the bacterial origin of spondylarthritis and the rôle of focal infection are reported.

(5) The fundamental difference between deforming spondylosis and primary spondylarthritis makes it desirable to confine the term "spondylarthritis" to those diseases that involve the articular processes.

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THE REGENERATION OF BONE TRANSPLANTS

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THE regeneration of a bone transplant has often been a matter of dispute during the past 45 years, and today the question is still unsettled. Ollier,[27] who was the first to perform systematic examinations of bone grafts, believes that a fresh autogenous or homologous bone transplant, covered with periosteum, is kept alive by its own periosteum, when the latter becomes quickly revascularized; and therefore, heterologous transplantation was of no use in comparison with autogenous or homologous grafting.

Ollier's conclusions were challenged by Barth and Marchand,[3] who reported that any bone graft, whether covered with periosteum or not, always became necrotic, in all its parts, *together with its periosteum and endosteum*, and the necrotic transplant gradually became regenerated through osteoblasts derived from the periosteum and endosteum of the neighboring sound bone. This process took place by direct replacement of the necrotic bone nuclei of the graft through the osteoblasts (the so called creeping substitution). According to this theory, either living or dead material could be used equally well for bone transplantation. Their observations, however, were in turn refuted subsequently by Axhausen,[2] after the performance of well controlled experiments, and by Lexer,[17] after clinical experience. They declared that the *transplanted periosteum and endosteum do not become necrosed, although the transplanted bone always dies*; the latter becoming regenerated by the *transplanted* periosteum and endosteum, after they have gained access to the general circulation. Phemister[29] came to a similar conclusion; namely, that osteogenesis in bone repair occurs from the inner layer of the periosteum, from the endosteum and, to a much less extent, from bone cells and fibrous contents of the haversian canals. Haas[9] also sees the source of regeneration in the periosteum, and Haldeman,[10] in a recent experimental study, considers the periosteum as the most important factor for survival of the graft. Gill[8] recommends the inclusion of periosteum and medulla in bone grafting.

Albee's[1] opinion is that the fate of the bone graft depends largely upon its exact environment and that survival is enhanced by good approximation of the components of the graft with the same components of the host bone. He further states that periosteum and marrow serve an important rôle in aiding to establish an early and abundant blood supply. McWilliams[22] is convinced that living bone grafts have life inherent in themselves, and the

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theory that contact with living bone is necessary for subsequent life of the graft must be given up; the influence of the periosteum is exerted in maintaining the nutrition of the graft.

Murphy,[24] however, believed that the graft is, per se, not osteogenetic but osteoconductive, and that the regenerative cells are supplied from the osteogenetic cells of the capillaries growing from the living bone. Macewen[20] denies any osteogenetic influence of the periosteum. According to him, the bone cells change into osteoblasts. Geddes[7] considers the periosteum only as a limiter to bone formation and far from being an osteogenetic membrane.

Another group of authors, Leriche and Policard,[16] Murray,[25] Bier,[5] Petrow and his pupils,[28] see the source of bone regeneration in metaplastic processes. They believe that the regeneration of a bone graft is carried out by fibrous tissue cells which, penetrating into the transplant, are converted into bone cells through metaplasia. According to these investigators, it is not absolutely necessary to transplant the graft covered with its periosteum.

Thus, the opinions concerning the source of bone regeneration still differ today: On the one hand, periosteum and the grafted bone, as the sole cause of regeneration; on the other hand, metaplasia as the chief cause. To settle this dispute would be of great importance clinically, not only in bone grafting, but wherever bone healing processes are met.

We believed that a thorough investigation directed more particularly to the processes of vascularization of a bone graft, after its transplantation, might help to settle this dispute. The literature concerning this fundamental question is rather meager. Läwen,[15] as far as can be ascertained, was the first to describe the blood supply of a bone graft, its vessels having been injected with Berlin blue. McWilliams, Phemister, Albee, Gill, and other authors examined histologically the vascularization of bone grafts. Phemister saw the entire haversian system of the transplanted bone restored by ingrowth of vessels from the periphery. Albee believes that the transplanted periosteum and endosteum aid to establish a quick vascularization to the graft, but that most of the blood supply to a graft is derived from the marrow. Lexer, Rubaschewa and Prives[30] studied the graft vessels by roentgenologic angiography, while Nemiloff[26] and Bertini[4] examined histologically the vessels after micro-injections with gelatin. It was stated that the blood supply of a bone graft was established from the transplanted periosteum after the latter had been revascularized, and later on also from the graft bed. Systematic examinations, however, which combined the injection of the vessels, roentgenologic angiography and histology are lacking.

Experiments* were, therefore, undertaken with the idea of investigating thoroughly the establishment of the blood supply of a bone transplant and the relation between vascularization and regeneration. Whole radii of dogs were taken out and again replanted in the original place, so that the blood

* The experimental investigation was made in the Research Laboratory of the Surgical Clinic of the University of Munich.

supply could be reëstablished only from the outside of the bone. On account of the difficulties encountered, the experiments succeeded in only a few cases.

The experiments were performed as follows: From a curved incision over the lateral border of the foreleg, a subperiosteal exposure of the radius was made, without separating the periosteum from the nutrient soft tissues. The humeroradial joint was opened and the insertion of the capsule detached from the capitulum radii. The same was done at the radiocarpal joint. Under continuous subperiosteal dissection, the whole bone, with both its joints, was removed and put in normal saline solution. After thorough hemastasis of the entire wound had been effected, the radius was replanted in its original place. The joint capsules were closed. The periosteum was sutured over the bone and the wound closed. A subperiosteal autogenous transplantation, therefore, was effected.

Twenty-five experiments were performed but an absolutely aseptic healing occurred in only four animals. In two of these the lines of the epiphysis were still open. Every eight days both forelegs were roentgenographed. The roentgenograms were always taken with the same technic. The dogs were killed under anesthesia after five weeks, ten weeks, four months, and ten months. Immediately afterwards both shoulder girdles were disarticulated and injected with a turpentine-mercury solution through the arteria axillaris. The radii were now exposed and removed covered with periosteum; roentgenograms were taken from two positions. The periosteum was then removed and the bones were reroentgenographed. Histologic examinations completed the investigations.

Anatomically considered, there are two vascular systems to be distinguished in the normal, long, medulated bone (Langer, Lexer, Delkes-Kamp,[6] Johnson, Kolodny[14]): the periosteal and intra-osseous. The periosteal system consists of a net of smaller and medium vessels which are derived directly from the surrounding soft tissues and are in intimate connection with them. Only a few small anastomoses connect the periosteal with the intra-osseous circulation. The intra-osseous system consists of three sets of vessels (Fig. 1). The first set is that of the diaphysis, containing the nutrient artery (Fig. 1*a*), which enters the bone as a single trunk, except at the femur, where it is double. Very soon it splits up into an ascending and descending branch and courses toward the metaphysis. The second set is formed by the metaphyseal vessels (Fig. 1*b*), which are branches of the vessels of the joint capsule. They penetrate the bone near the insertion of the capsule beneath the epiphyseal line and supply the metaphysis. The third set is that of the epiphysis (Fig. 1*c*), the vessels of which are derived from the joint ligaments. In youth the three intra-osseous sets are connected only by a few anastomoses. With growth, the anastomoses become more numerous, and after the period of development, the three sets form one system.

In dogs, the vascular conditions of long medulated bones are the same as in human beings, with one exception. During the period of development, the

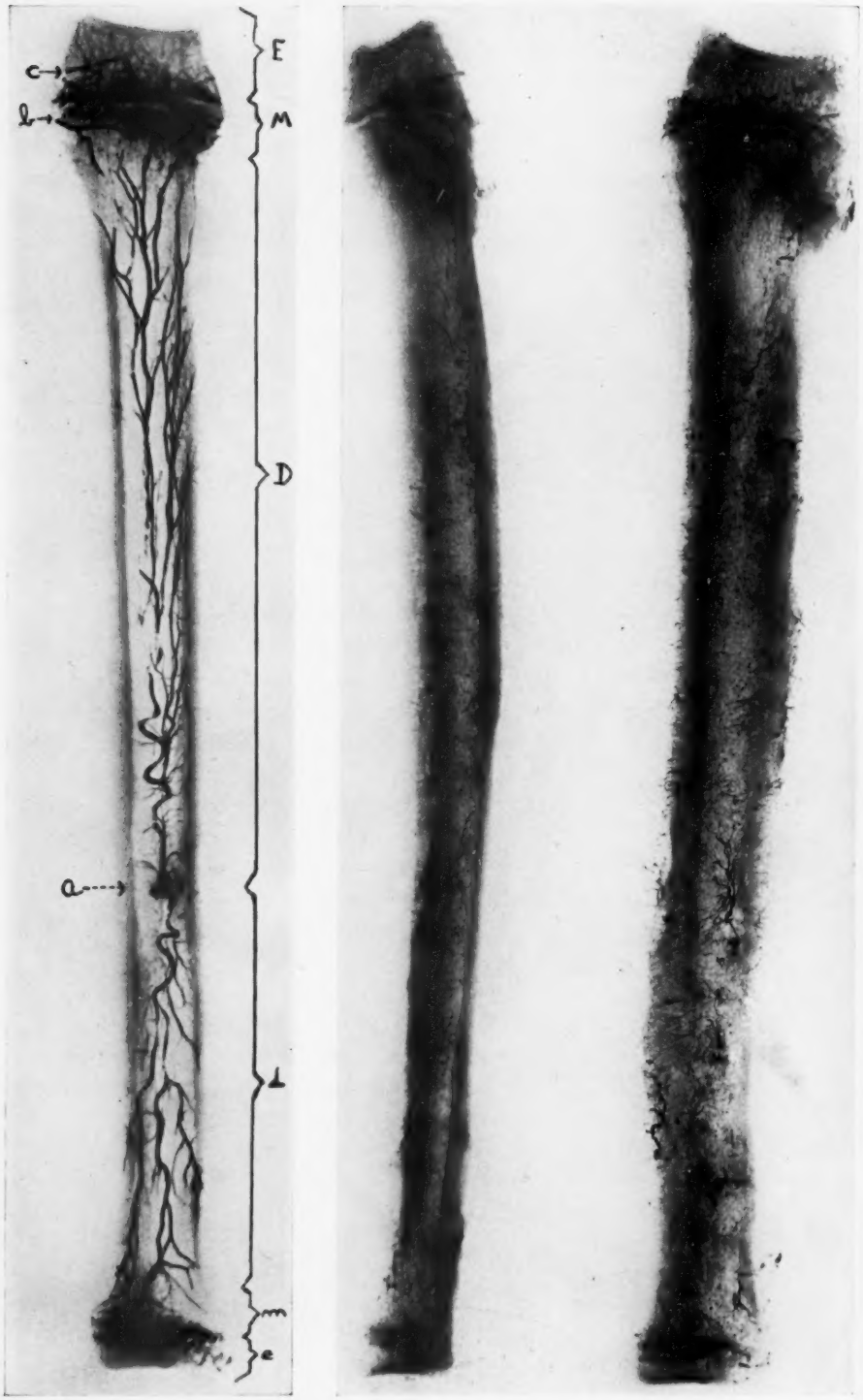

FIG. 1.—Radius of a growing dog near the end of development. Vessels are injected with a turpentine-mercury solution. The distal part (DME) is still growing; distal epiphyseal line is to be seen; vascular areas are still separated from each other. Proximal part (dme) is beyond period of development. Vessels have passed over into one another. (*a*) Entrance of the nutrient artery. (*b*) Entrance of the metaphyseal artery. (*c*) Entrance of the epiphyseal artery.

FIG. 2.—Representation of the bone vessels five weeks after subperiosteal reimplantation of the radius.

epiphyseal and metaphyseal vessels in man do not penetrate through the epiphyseal line and are therefore absolutely separated from each other (Schulze[31]). The blood supply of a transplanted bone, however, is developed in a different way, as seen from the experiments. The four specimens, five weeks, ten weeks, four months, and ten months, postoperative, represent stages through which any transplant goes. The first stage (Dog 1) comprises the time during which the graft is dead. The second stage represented

FIG. 3. — Bone vessels ten weeks after subperiosteal reimplantation of the radius.

FIG. 4.—Bone vessels four months after subperiosteal reimplantation of the radius.

FIG. 5. — Bone vessels ten months after subperiosteal reimplantation of the radius.

the period during which the graft became transformed into living bone (Dogs 2 and 3), and the third stage was that of the so called functional adaptation (Dog 4).

At the first stage (Fig. 2), the roentgenogram revealed numerous small vessels coming from the periosteum and penetrating the cortex through the enlarged haversian canals. The blood vessels of the periosteum displayed not

only hypertrophy but also hyperplasia, *i.e.*, a great increase in number of vessels. At first sight, one might think that the vessels of the graft were irregularly distributed, but on microscopic examination, it was striking that certain parts of the bone were especially and quickly preferred. This fact argues for the importance of quick vascularization of these regions. These were the parts beneath the joint cartilage, and, in growing dogs, the parts around the epiphyseal lines. The second type of vascularization was formed by large vessels which penetrated the bone at certain places. They are less

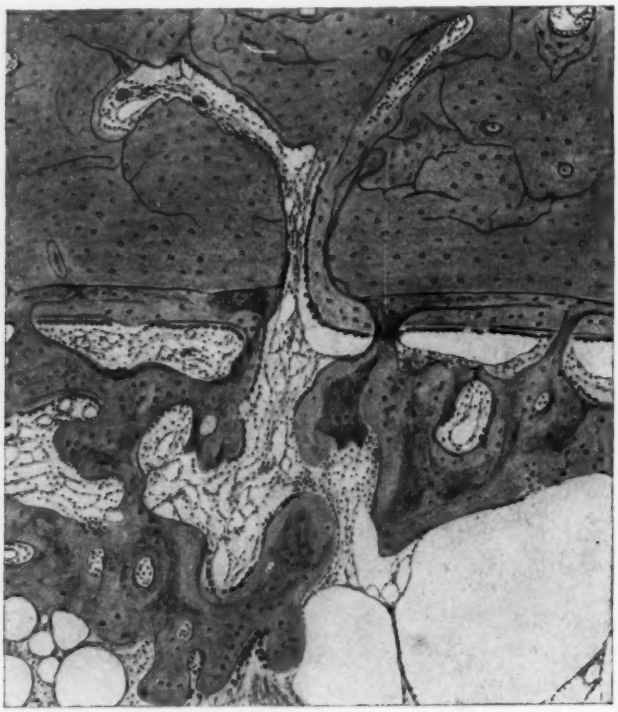

FIG. 6.—Section of a grafted diaphysis (ten weeks postoperative) which was surrounded by periosteum; the cortex is still dead, but the trabeculae are already transformed into living bone tissue by osteoblasts, which, penetrating through haversian canals, can be seen in their bone substituting action.

important at first than the smaller ones, but their distribution indicated they were predestined to become main vessels.

At the beginning of the transformation stage (Fig. 3), the whole graft was supplied by numerous smaller and larger vessels. This stage represented the height of vascularization. Later on, at the end of the transformation stage, the small vessels had disappeared, while the large ones progressed. The periosteal network had decreased to normal size. After substitution and functional adaptation of the transplanted bone, the picture presented a well arranged system of vessels (Figs. 4 and 5).

The establishment of vascularization of a bone transplant is, therefore, not aimless but is purposeful, designed to supply the biologically important parts as quickly as possible.

The histologic examination, compared with the roentgenologic observations, revealed the following findings: The graft always died after transplantation; many of the nuclei disappeared, others were degenerated; the cortex lost its normal color. In comparison with the bone, the *marrow* behaved differently. Although necrobiotic and necrotic spaces were still visible, a greater part had regenerated, especially at certain places. The marrow was

FIG. 7.—Resorption of a piece of graft that was denuded of periosteum; erosion by fibrous tissue containing giant cells (five weeks postoperative).

regenerated, in part, absolutely transformed into myeloid tissue, in regions where there was a preferred vascularization from the start, *i.e.,* beneath the joint cartilage and around the epiphyseal lines. The spongy spaces beneath the joint cartilage were filled with living marrow. The medullary spaces above and below the epiphyseal lines were restored to such degrees that they could not be distinguished from those of the unoperated side. But the center of the epiphysis and parts of the diaphysis which, up to that time, had not been reached by blood vessels were found necrotic. Later on (from two and one-half to four months postoperative), the dead graft was transformed gradually into living tissue, by the so called creeping substitution of the dead bone by new bone. This process was carried out by osteoblasts which accompanied the periosteal vessels on their way through the haversian canals

(Fig. 6). At the same time new bone is produced outside by the periosteum. In ten months after operation, the entire graft is revitalized.

There are, however, instructive exceptions. As mentioned above, the periosteum was sutured over the replanted bone. At some places this was impossible, because parts of the periosteum had been destroyed during operation, allowing areas of the graft to be in contact with fibrous tissue. These parts presented significant differences from normal bone regeneration, although, as might be predicted, *the vascularization of the bone was not excep-*

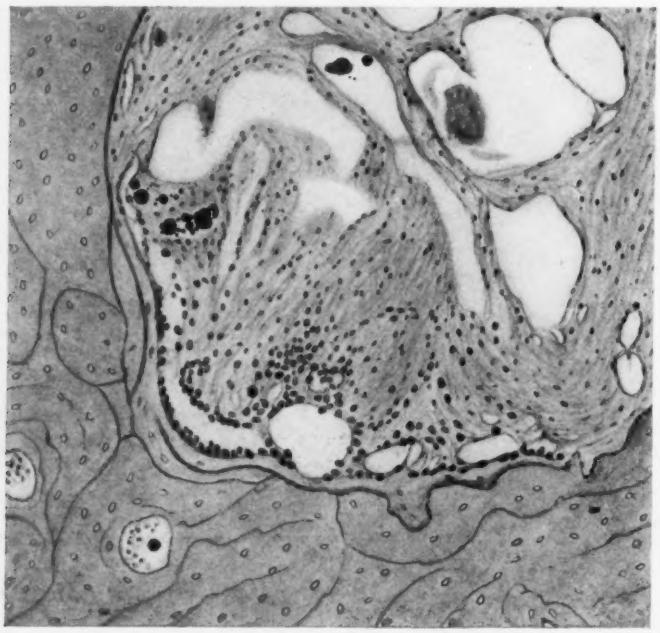

FIG. 8.—Osteoblastic action seen in a bone section which was denuded of periosteum.

tional. No signs of destruction were shown in the periosteal covered bone, and no osteoclasts were to be seen, *i.e.*, transformation was carried out entirely through osteoblasts, but lacunar resorption played the principal rôle in those places where the periosteal coverings were destroyed. The surface of the bone was eroded by giant cells (Fig. 7). Fibrous tissue, penetrating from without, destroyed the walls of the haversian canals. Processes of destruction and absorption, caused by the absorbing power of fibrous tissue, governed the field. In addition to the resorption there were, here and there, signs of regeneration, probably due to metaplastic processes by cells of vessel walls (Keith[12]) or, what is more likely, by surviving osteoblasts (Fig. 8). Therefore, by ingrowth of fibrous tissue into the dead transplant, processes of resorption and also osteoblastic apposition occur. However, it is a well

known fact that the latter does not often take place and could be found in only a few places in these experiments.

Knowledge of the regenerative processes involved in the transformation of a bone transplant into living bone clarifies one's understanding of how transplantation of bone and after treatment must be carried out, to obtain successful results.

Starting from the principle that living periosteum and endosteum guarantee normal bone regeneration, in contradistinction to fibrous tissue, which erodes and resorbs the graft, it is apparent that the periosteum of the host bone, or, when that is impossible, a graft covered with its periosteum, must be used. But this alone will not suffice. The second important requirement is to encourage quick vascularization which prevents necrosis of the periosteum and maintains its regenerative power.

The operation, after the usual aseptic precautions, begins with preparation of the host bone. The incision through the skin is curved, so that the subsequent scar will not encroach upon the graft. A tourniquet should not be used. All the bleeding points should be ligated so that the wound is absolutely dry; otherwise, hemorrhage prevents the first adhesions between soft tissue and the periosteum covered graft. When the bed is exposed, a careful examination for cicatricial tissue is made. It must be completely removed, because white, glassy tissue is an obstacle to vascularization. The space prepared in the bone which receives the graft must correspond in size and shape to the graft. In nonunited fractures, all cicatricial tissue must be removed from the ends of the bones and between them. If the bone ends are atrophic and sclerotic, resection of the pseudarthrosis should be carried out, no matter how large the resulting defect. There must be quick organic fusion between graft and graft bed.

The preparation of the graft itself, usually taken from the anterior surface of the tibia, depends upon the special purpose for which it is to be used. There are several individual methods available and well described in special treatises: Lexer's simple splinting, recessed splinting, splinter locking, Albee's inlay method, Henderson's[11] massive graft, Campbell's onlay graft, *etc.* After the graft has been made to fit, it is brought into contact with the stumps and fastened. I prefer wire for this purpose. Of other material, kangaroo tendon, beef bone screws, or autogenous bone pegs may be used. Albee incises the periosteum in numerous places to provoke greater stimulation and better blood supply. In cases of intramedullary pegging or bridge pegging, it is important to remove the periosteum of the transplant where it comes into contact with the endosteum of the medullary cavity. The wound is now closed. Care must be taken that the soft tissues lie closely around the bone.

The after treatment is as important as the operation itself and is carried out according to the course of the regenerative processes. As stated above, we can clearly distinguish three stages: First, the stage during which the graft is dead; second, the stage of transformation by substitution of the dead

osseous tissue by living tissue. The osseous structure condenses and the surface becomes smooth. Organic fusion occurs between graft and stump; third, the stage of functional adaption in form and increased strength of the graft to its mechanical requirements, whereby the graft becomes thinner or thicker, according to the functional demand. The amount of growth in a bone depends on the need for it (Murphy).

From this is derived the important principle of the after treatment of bone transplantation, *i.e.*, absolute immobilization of the grafted limb during the stage when the graft is dead and being transformed. It is during this stage that the transplant has the least resistance, not only to rough handling, but also to minor influences, especially when the latter are ever present. Therefore fractures or formation of fissures are the consequence of too early mobilization. But that fractures of bone grafts can be healed by immediate complete immobilization is shown by Muller[23] and others.

The formation of fissures in bone transplants has often been discussed. At present it is generally believed that they begin as simple transverse clefts gradually progressing between the osteon columns which are not yet cemented to each other. Later these clefts are filled by fibrous tissue and enlarged by resorption. They develop in grafts not completely regenerated as the consequence of slight but continual mechanical stimuli. They are especially seen in the segments of limbs possessing two bones, because the sound bone keeps up a continuous spring-like action. Lexer has recommended osteotomy of the sound bone to counteract this, followed by absolute immobilization. This treatment has often been employed with success. Thus the grafted limb must be absolutely immobilized; rotary movements are prevented until the roentgenogram shows good fusion between stumps and graft, and advanced regeneration of the latter, usually between eight and ten weeks. Dressings can then be partly removed and the usual physiotherapy begun.

Among unusual conditions, bone grafting after osteomyelitis might be mentioned. It cannot be too strongly emphasized that such cases should not be touched until at least nine, or better, 12 months, after the last fistula has closed and the infected focus has disappeared. After this time, primary postoperative healing processes can be expected. If infection sets in, however, the transplant need not be removed immediately, for it often happens that in spite of the formation of pus, the entire graft, or parts of it, heal. Only when a part or all of the transplanted bone appears as a sequestrum should it be removed.

Other unusual conditions are extensive formations of scars, especially of the skin. In these cases the entire cicatricial tissue should be removed and the defect covered by skin flaps, before bone grafting is performed.

Finally, a short description can be given of the recently recommended transplantation of spongiosa bone. It was observed (Macewen, McWilliams, Phemister, Keith) that, in contrast to large pieces of grafted cortex, areas of cortex which were shaved into small pieces and transplanted remained alive.

Moreover, it was found out (Lexer, Matti[18] Henderson, McGraw, and Harbin[21]) that spongiosa bone shaved into small pieces and transplanted in all its parts, practically, can be saved, because its loose structure gains quick access to the blood and lymph circulation. Therefore transplantation of spongy bone can be carried out successfully in certain kinds of nonunions, where the fibrous disk between the stumps is small, the fragments are in alignment and the periosteal covering preserved. The method is performed as follows (Matti): After exposure of the pseudarthrosis, the stumps are chiseled open longitudinally until the medullary cavity is opened widely. The dense interposed fibrous disk must be excised, with the exception of a small posterior bridge which holds the cortex of both fragments in connection and maintains the correct position. Spongiosa is taken from the trochanter region of the femur and splintered into small pieces with which the defect is completely filled. Then the periosteum and soft tissues are closed over the grafted spongy bone material, the skin sutured, and absolute immobilization maintained until the pseudarthrosis has healed. Henderson, for the same reason, by using massive grafts, advises the filling of the cleft between graft and graft bed with spongy bone.

SUMMARY.—Experiments are described in which subperiosteal transplantations of entire radii of dogs have been performed. The transplants, blood vessels of which have been injected with a turpentine-mercury solution, have been examined roentgenologically, macroscopically and microscopically, five weeks, ten weeks, four months and ten months, postoperatively.

The purpose of the research was:

(1) To investigate the establishment of vascularization of a bone transplant and the relation of vascularization to regeneration.

(2) To parallel the clinical side.

CONCLUSIONS

After transplantation of a bone, smaller and larger vessels grow from the periosteum into the graft. The smaller vessels advance more rapidly, but they regress as soon as the larger vessels progress, until finally the entire graft is supplied by a well arranged vascular system.

Under the microscope the osteocytes of the graft have always been found dead. Later on, the dead bone becomes transformed into living bone tissue by osteoblasts which accompany the ingrowing vessels, but only if the graft is protected by periosteum. If it is denuded of periosteum, the graft becomes destroyed by the ingrowing fibrous tissue, and only small portions of the transplanted bone may be saved by surviving osteoblasts. The periosteum, therefore, is the only reliable factor in regenerations when an entire bone, with its medullary cavity closed, is transplanted.

The technic of bone transplantation and after treatment are described in parallel to bone regeneration.

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BRIEF COMMUNICATIONS AND CASE REPORTS

AN INCISION FOR COMPLETE BREAST AMPUTATION*

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IN PRESENTING another incision for the so called radical amputation of the breast, the author is quite aware that no single incision is suitable for all types of malignant breast tumors. The location and size of the tumor and the size and shape of the breast must of necessity be factors in the type of incision best suited for the individual case. The type of incision here presented, however, is suitable for most cases. It has all of the advantages of affording one a good exposure of the axilla, places the scars as far away from the axilla as possible and with proper postoperative care permits the maximum of arm and shoulder function.

Operative Technic.—With the arm in the usual position at right angles to the body and the breast held downward by a tenaculum, placing the skin on tension, an incision is begun 5 cm. (two inches) below the middle of the clavicle and extended downward and outward to meet an incision extending downward and inward from the edge of the latissimus dorsi muscle, beginning 5 cm. (two inches) below the posterior axillary fold. These incisions outline a triangular skin flap which includes the axillary area. From these two oblique incisions two other incisions branch off near the apex of the triangle in sweeping curves around the breast to meet at the costal margin in the midclavicular line (Fig. 1 A).

After outlining the skin incisions, the triangular axillary skin flap is carefully dissected upward and retracted outward over the shoulder. A thin layer of fat is left attached to this flap which will later be placed in contact with the axillary vessels and nerves. The incisions as outlined about the breast are then partially completed to enable the operator to adequately expose the entire axillary area for dissection. The axillary dissection is completed in the usual manner before the breast is removed.

After complete removal of the breast, closure is first made between each margin of the triangular flap and the lateral flaps. This permits the proper fitting of the apex of the triangular flap between the lateral flaps. Skin grafts may be applied when necessary as with any other type of incision. A drain is placed at the end of the posterior incision (Fig. 1 B, C, D), to be removed in 24 hours.

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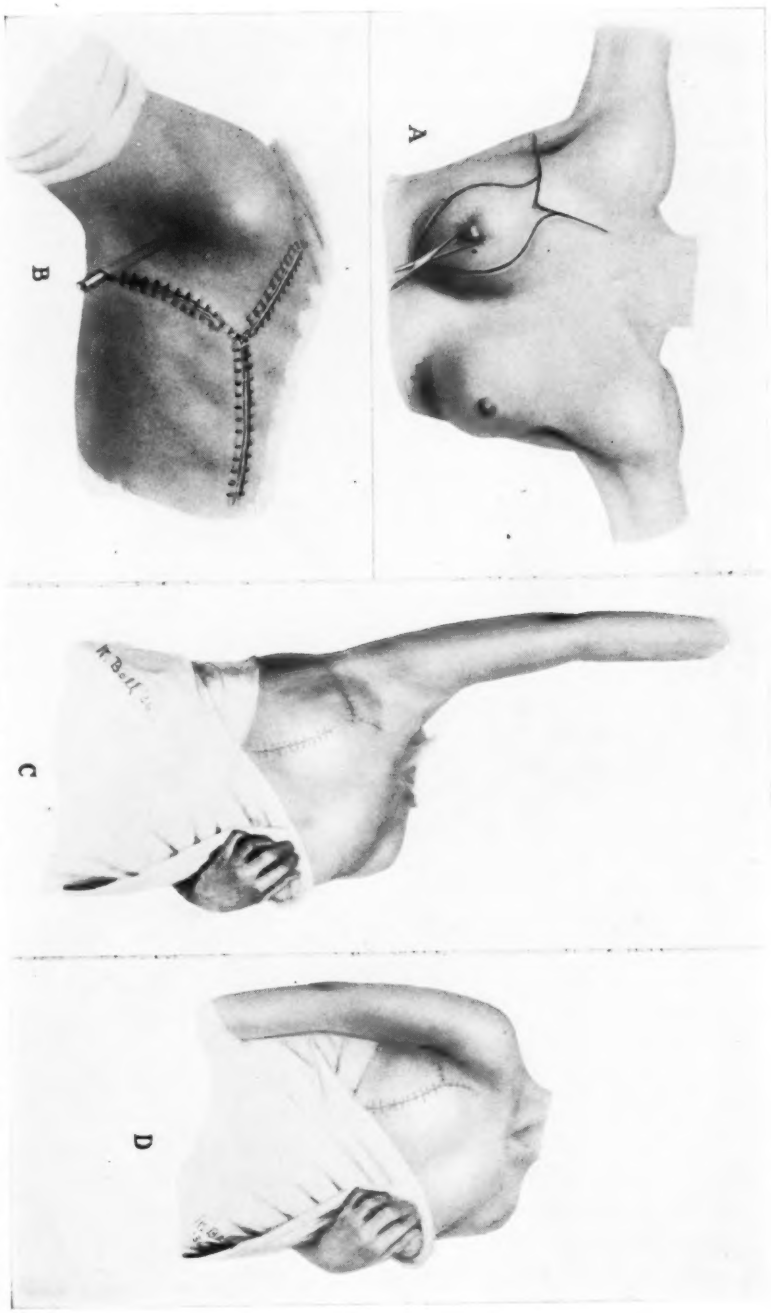

FIG. 1.—(A) Lines of incision for complete breast amputation, using triangular axillary skin flap. (B) Closure of incision with drain. Very fine approximation sutures used at tip of flap to prevent sloughing. (C) Showing position of scar after healing. (D) Showing skin folded high in axilla.

The wound is dressed after carefully pressing the axillary skin flap high in the axilla against the axillary vessels and chest wall. The flaps are held in snug contact with the axillary and chest walls by the use of moist sea sponges (Fig. 2 A, B), as recommended by Blair[1] for full thickness skin grafts, and by Davis and Traut[2] for surgical dressings. It is advisable to change the dressing in 24 hours so that the condition of the skin may be noted and any accumulation of serum or blood be evacuated. The sea sponge dries and forms an exact mold of the axillary area. It should be carefully

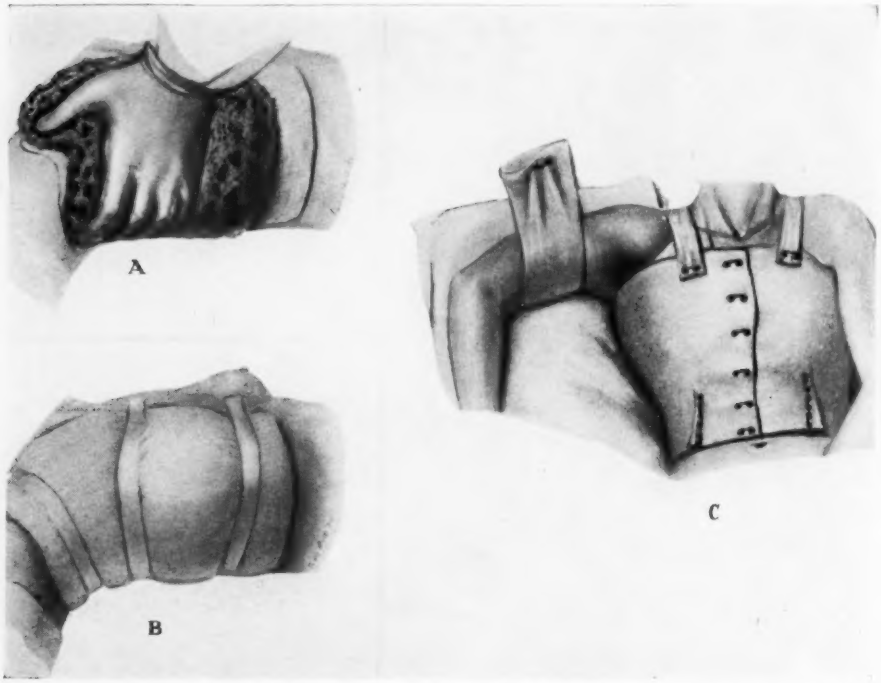

FIG. 2.—(A) Sea sponge placed high in axilla to hold skin flaps snugly against chest wall and axillary vessels. (B) Dressing in position covering sea sponge. (C) Complete dressing with patient in bed. Arm is held in abduction from five to seven days with towel pinned to head of mattress.

replaced over a light gauze dressing so that excessive pressure on the skin may not damage the blood supply. The sea sponge dressing is discontinued in five to seven days. The arm is held in abduction at right angles to the chest wall for seven days by a towel support pinned to the head of the mattress (Fig. 2 C). Moderate exercise of the arm and shoulder is begun on the third postoperative day. After the first postoperative day it is advisable to release the arm from its support for an hour once or twice each day to permit the patient to change position.

The advantages of this incision are:

(1) Adequate axillary exposure.

(2) It places the scars so that they do not cross the axilla between the upper arm and chest wall.

(3) The scar does not come in contact with the axillary vessels which are covered by the smooth axillary triangular skin flap.

(4) An adequate skin flap is preserved to fold high in the axilla by sea sponge pressure dressing. This prevents the accumulation of blood and serum beneath the skin flap along the axillary vessels and brachial plexus. Healing with firm contact between the skin flaps and high axillary structures minimizes scar formation and increases arm and shoulder function.

The disadvantages of the incision are:

(1) It is inadequate for the removal of very large breast tumors, especially when they are located near the axilla or when the skin of the lower axilla is involved.

(2) The apex of the triangular flap may slough because of insufficient blood supply.

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INTRATRACHEAL THYROID

OCCURRING IN A SEVEN MONTHS HUMAN FETUS

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INTRATRACHEAL thyroid is of sufficient rarity to warrant the publication of additional observations on its occurrence. Schachenmann[5] (1924) in reviewing the literature has collected 35 cases, and four additional cases have since been reported. The one herewith reported presents the unusual feature of occurring in a seven month old fetus, while the youngest case heretofore described was in a five month old child. While all other cases were discovered because of obstructive symptoms, the present instance was purely an accidental finding, occurring in a series of sections made for routine class use.

Description of the Tumor.—The tumor consists of five small nodules of thyroid tissue, connected together by short peduncles or necks. The mass is unilateral and situated between the cricoid and the first cartilaginous ring near the junction of the trachea and esophagus. The greatest diameter of a single nodule is 36 mu. The tumor extends through 24 sections, each 10 mu thick. Four of the nodules lie well within the ring formed by the first tracheal cartilage and the lower border of the cricoid, but the fifth lies in an extracartilaginous position, and is connected by a neck to an inner nodule. The nodules are made up of typical acini and some cell cords. The characteristic staining reaction for juvenile colloid is marked. The mass has no effect on the inner

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contour of the trachea. The only other abnormality noted in the preparation is that some of the glands of the tracheal mucosa extend over and in front of the tracheal ring to assume an extracartilaginous position (Fig. 1).

Discussion.—One of the mooted points concerning the origin of intratracheal thyroid is whether the tissue represents a true invasion from outside or an abnormal early fixation of the thyroid about which the tracheal cartilages form. Our case does not settle this point but it does indicate that the latter explanation is the more plausible, since it would account for the ab-

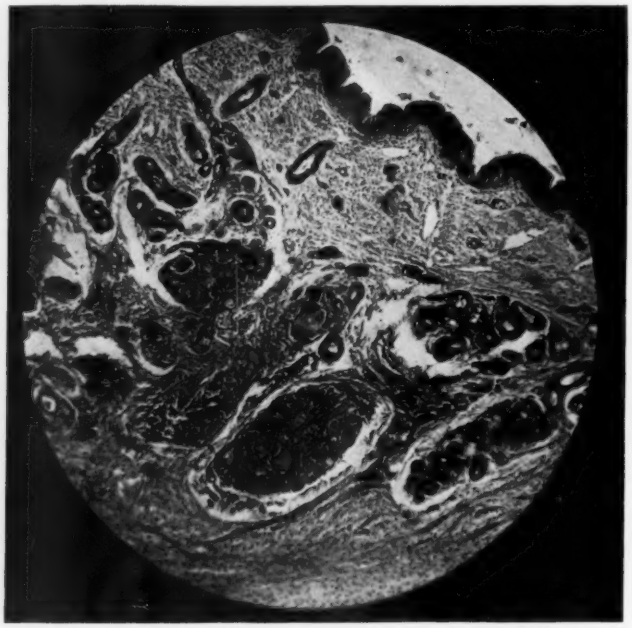

FIG. 1.—Photomicrograph of a section of the wall of the trachea of a human fetus showing an intratracheal thyroid (×750). The lobules in the center of the field are thyroid; those at the margins are mucous glands.

normal position of the mucous glands and for the dumbbell shaped lobule of the aberrant thyroid as well. On mechanical grounds it is hardly probable that the invasion of the trachea by the tumor could force the mucous glands out of their normal position, particularly since the glands in the immediate vicinity of the mass show no signs of lateral compression.

The hypothesis of abnormal fixation is further supported on embryologic grounds since the cartilages are not complete at the 43 Mm. stage (Macklin,[3] 1921), and the separation of the lateral lobes of the thyroid is effected from the pharynx near the tracheolaryngo junction at about the 18 Mm. stage (Weller,[7] 1933). Hence the most acceptable explanation of this tumor is that there was an early abnormal fixation of the tip of the lateral lobe of the thyroid and that the cartilages grew around enclosing it.

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RECURRENT REGIONAL (TERMINAL) ILEITIS

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SINCE the article by Crohn, Ginsberg and Oppenheimer[1] describing a disease of the terminal ileum which they called "Regional Ileitis," a great deal of interest in this condition has been manifested and many other cases have been reported.

As resection of the diseased portion of the bowel has apparently resulted in cure of the condition in many of the cases reported, it is thought that the recitation of the history of a patient who has had two recurrences following complete excisions of the apparently diseased bowel may be of interest.

Case Report.—A male Hebrew, age 27, first presented himself in March, 1923, complaining of various persistent symptoms referable to the gastro-intestinal tract. For some eight months he had been complaining of anorexia, abdominal distress after eating, heartburn, and intermittent attacks of pain in the right lower quadrant of the abdomen. The pain seemed to be brought on by exertion and was occasionally accompanied by vomiting. He had lost 20 pounds in weight since the onset of his illness.

At the time of examination there was evidence of recent loss of weight and of a moderate degree of anemia. Temperature 99.5° F. The abdomen was soft except over the lower right quadrant, where there were considerable muscle resistance and a definite localized tenderness. No masses were appreciable by palpation. Provisional Diagnosis: Appendicitis.

Operation.—March 31, 1923. Under general anesthesia, palpation of the abdomen revealed a sausage shaped, freely movable mass in the right lower quadrant, which had previously been obscured by the spasticity of the overlying muscles. The abdomen was opened though a right rectus incision. A sausage shaped mass presented, which was identified as a very much thickened, indurated terminal ileum, the distal eight inches of which were involved in the pathologic process. It was bluish-red in color, its surface smooth and not adherent to adjacent viscera. The pathology began very abruptly in the lower ileum and ended at the ileocecal junction, the cecum and appendix not being involved in the process. The mesentery along the length of diseased segment was considerably thickened and edematous and contained many large nodes. With the exception of moderate dilatation of the ileum above the diseased area, the remainder of the small intestine and the large intestine with their mesenteries appeared normal.

A wide resection was decided upon. The lower ileum and cecum were resected, the proximal site of the resection being well above the diseased area in the ileum, and the lower including the cecum, and the normal appearing appendix being removed together

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with the diseased bowel. An end-to-side anastomosis was effected and a small enterostomy tube placed in the ileum a few inches proximal to the anastomosis.

Pathologic Examination.—Gross: Longitudinal section showed a marked thickening of the submucosa with hypertrophy and furrowing of the mucosa, but only a moderate amount of ulceration. The lumen of the bowel was constricted to less than one-fourth its normal size. The entire mass was firm and leathery in consistency and the area of disease was sharply demarcated from the normal bowel at either end of the specimen.

Microscopic Examination.—Dr. Lester Newman: "Section of intestinal wall shows a chronic inflammation of the mucosa and submucosa. The muscular coats show a very great hypertrophy. Isolated groups of small round cells are to be seen scattered throughout the specimen, usually arranged around the blood vessels. It is not possible to make an etiologic diagnosis."

The postoperative course was uneventful and the patient left the hospital on the seventeenth postoperative day. He rapidly regained his weight and strength, and with the exception of a tendency to loose stools, which responded to dietary regulation, he was symptomatically cured.

In November, 1926, three and one-half years after operation, he returned complaining of intermittent pains in the lower right quadrant of the abdomen which he had first noticed a few months previously and which were becoming more distressing. He had also recently lost ten pounds in weight. He stated that his health had been excellent since the operation, and that he had led a very active life, playing a great deal of tennis, and experiencing no abdominal discomfort until a few months prior to consultation. He had, however, continued to have occasional loose stools when not careful of his diet.

At the time of this examination there was a palpable mass in the right lower abdomen just beneath the old operative scar. This was tender but freely movable and similar in size and shape to the tumor previously removed.

Roentgenologic examination after a barium enema showed a definite obstruction, apparently, at the junction of the colon and ileum.

Second Operation.—November 15, 1926. The terminal ileum was found to be involved in a process similar to that found at the previous operation. The diseased area was again well defined, beginning abruptly six inches above the line of anastomosis with the colon and ending sharply at this point. The ascending colon and remainder of the small bowel were not involved. There were no adhesions and the gut was easily resected, removing the terminal ileum *ten inches* above the diseased area and the greater part of the ascending colon together with the mesentery. An end-to-side anastomosis was effected and an enterostomy tube placed a few inches above this in the proximal ileum.

Pathologic Examination of the specimen showed the identical picture both grossly and microscopically as that in the intestine removed at the previous operation.

The patient again improved rapidly following operation, and in a few weeks returned to work, free of all symptoms except the tendency to have loose stools which troubled him only occasionally.

In September, 1935, he reported for an examination, stating that he had been well until the preceding July, at which time he began to feel "run down" and noticed that he was losing weight. There was also some pain in the right lower quadrant of the abdomen, and on several occasions there had been severe colicky pains throughout the abdomen with intermittent diarrhea and constipation. He had lost ten pounds in weight during the past two months.

Examination of the abdomen revealed a definite sausage shaped mass in the right lower quadrant, freely movable and quite tender, and similar in all respects to those found on the two previous occasions. Temperature 99.5° F.; pulse 100. Another recurrence of the terminal ileitis was suspected.

Third Operation.—September 12, 1935. The same gross pathology was encountered in the terminal ileum as that which had been present at the two previous operations. The limits of the diseased portion of the bowel again appeared well defined, beginning

proximally at a point about 12 inches above the ileocolic anastomosis and ending at the line of the anastomosis. The mesentery of this diseased portion was very much thickened and edematous and contained many large lymph nodes. No other pathology was found except numerous adhesions along the site of the previous anastomosis.

Resection of the terminal ileum was undertaken from a point well proximal to the diseased process, and which included the hepatic flexure of the colon distally. An end-to-side anastomosis was effected between the ileum and transverse colon. A small enterostomy was placed in the ileum proximal to the anastomosis.

The specimen was grossly similar to those previously removed, the walls of the affected area being greatly thickened and the lumen so encroached upon and distorted as to be almost obliterated.

The patient recovered rapidly from the operation, and appears to be entirely well up until the present time, 14 months postoperative.

SUMMARY

A case of localized terminal ileitis is presented that has recurred twice following resection of the diseased portion of the bowel, after intervals of three and one-half and nine years respectively.

It will be remembered that at the time of the second operation a considerable length of apparently undiseased bowel was removed both above and below the diseased area, and that the thickened mesentery was also removed in the hope of preventing any further recurrence. Recurrence, however, did occur almost nine years following this radical resection, and operation was again required for relief of obstructive symptoms. Wide resection was again employed, and although the patient is now apparently well, we are not confident of permanent cure.

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PROLONGED SURVIVAL FOLLOWING CHOLECYSTOGASTROSTOMY FOR OBSTRUCTIVE JAUNDICE DUE TO CARCINOMA OF THE HEAD OF THE PANCREAS

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IN A recent review of the end-results of cholecystogastrostomy,[1] it was found that the average postoperative duration of life for carcinoma of the head of the pancreas was approximately seven months. It has been the experience of many observers[2, 3, 4] that these patients almost always die between three months and one year after the operation. On the other hand, cholecystogastrostomy in cases of nonmalignant obstruction is compatible with a normal life expectancy.[4]

When a patient, however, lives longer than 15 or 16 months after chole-

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cystogastrostomy for supposed carcinoma of the head of the pancreas, the correctness of the diagnosis may be questioned, and unless a postmortem study is available, the exceptional cases of delayed metastases and prolonged survival cannot be accepted with certainty. Thus, in a recent communication,[5] a patient is described who lived four and one-half years before evidence of metastases were noted. Since no postmortem examination was obtained, however, the possibility of a nonmalignant obstructive jaundice, followed later by an intra-abdominal carcinoma with metastases, may well be entertained.

The following case is reported because of several interesting features, including a prolonged survival following cholecystogastrostomy with the absence of any metastases.

Case Report.—(No. 362961.) M. S., an Austrian Jew, age 60, was admitted to the Mt. Sinai Hospital February 22, 1934. His present illness began with jaundice four weeks before admission; this increased in severity, and was associated with nausea, vomiting and moderate epigastric pain. He noted that his stools were clay colored and that his urine was a deep yellow. Moderate pruritus and weakness were present, and he had lost 14 pounds in weight. He evidenced polydypsia, urinary frequency and nocturia, and had been told that sugar was present in his urine. His past and personal history was irrelevant except for an episode five years previously which had required hospitalization. Tremor was the predominating symptom at that time and the discharge diagnosis was psychoneurosis or hysteria. His wife showed a four plus blood Wassermann for which she had been treated.

Physical Examination revealed a deeply jaundiced, thin man with no positive findings except those in the abdomen. The edge of the liver was palpable 3 cm. below the costal margin and an indefinite mass, thought to be the gallbladder, was felt. There was slight tenderness in the right upper quadrant. The lower pole of the spleen could be palpated. Blood pressure 150/84.

Laboratory Data.—White blood cells 6,800, polymorphonuclear leukocytes 77 per cent, lymphocytes 22 per cent, and monocytes 1 per cent. Hemoglobin 94 per cent. Blood Wassermann negative. Total blood cholesterol 1,165 mg. per 100 cc., 750 mg. of this amount being in the form of esters. Icteric index 120, the van den Bergh test was direct and promptly positive, the indirect was 1: 20,000. Serum bilirubin 8 mg. per 100 cc. Coagulation time four minutes; bleeding time 45 seconds. Blood amylase 10.7 units. Blood sugar 170 mg. per 100 cc. Examination of the stool showed no bile or urobilin. The urine contained a trace of albumin, 2 per cent sugar in the 24 hour specimen and three plus bile. A gastro-intestinal roentgenologic study was negative.

Preoperative Diagnosis.—Obstructive jaundice due to carcinoma of the head of the pancreas, although the possibility of a common duct stone could not be ruled out. The patient was thought to have diabetes or an hepatic glycosuria. On a diet of 200 Gm. of carbohydrate, 6 Gm. of protein and 4 Gm. of fat, it required 100 units of insulin daily to render the urine sugar free.

The patient was prepared for operation by repeated small doses of moccasin venom and by intravenous infusions of 5 per cent glucose in normal saline with sufficient insulin to utilize the glucose.

Operation.—March 2, 1934. Spinal anesthesia. The gallbladder was found to be distended and 100 cc. of mucoid bile were aspirated from it. No calculi were palpated either in the gallbladder or in the common duct. In the head of the pancreas, near its upper margin, a very hard nodule, about the size of half a walnut, fairly typical of a small carcinoma, was palpated. There were no lymph nodes appreciable, and no evidence

of any metastases elsewhere in the abdominal cavity. A cholecystogastrostomy was performed by means of a suture anastomosis.

Postoperative Course.—The patient had a slow but progressive convalescence, the jaundice completely disappearing. He had several episodes of confused mental state accompanied by perspiration and appeared to be in insulin shock. One of these occurrences took place even while he was receiving an intravenous infusion of 5 per cent glucose solution in normal saline, at which time the blood sugar was found to be 25 mg. per 100 cc. This status was interpreted as a rapidly increasing sugar tolerance which occurred coincidentally with the subsidence of his jaundice. In fact, after 24 days, no insulin was required for the same diet that had previously required 100 units. The glycosuria was thus thought to be the result of an hepatic disturbance.[6] Another interesting feature was the fact that during convalescence, the blood amylase rose to 31 units from the level of 10.7 units which was present on admission. Whether this indicated pancreatic damage or not could not be proved. The patient was discharged April 5, 1934.

Follow Up.—When seen May 19, 1934, the patient was well, not jaundiced; had gained 15 pounds in weight, and was asymptomatic. A gastro-intestinal series made December 19, 1934, showed no abnormalities except that the biliary system appeared to be full of air. The patient continued well until February 15, 1936. In fact, he was so well that the correctness of the original diagnosis was questioned, and it was thought that perhaps a chronic pancreatitis might equally as well have accounted for the original symptoms and the present well being of the patient. However, on the latter date, he complained of abdominal cramps associated with diarrhea of three months' duration. At this time a gastro-intestinal series showed slight deformity of the duodenal bulb but was otherwise negative. On April 18, 1936, the patient complained of increasing pain in the upper abdomen with loss of weight. He was not jaundiced. Sugar was again present in his urine and he was under the care of the Diabetic Clinic.

Subsequent Admissions to Another Hospital.—The patient was admitted to another institution April 25, 1936, complaining of para-umbilical pain, constipation, loss of weight, and continuous vomiting after meals, which was not relieved by medication. He appeared cachectic, dehydrated, and chronically ill. A firm, tender mass was palpable in the right upper quadrant. Roentgenographic examination of the gastro-intestinal tract showed gastric retention after 24 hours and barium in the common and hepatic ducts. There was evidently an obstructive lesion in the region of the duodenum or pylorus. On May 23, 1936, an exploratory celiotomy was performed. The region of the cholecystogastrostomy was buried in a mass of adhesions and was not exposed. A posterior gastrojejunostomy was performed to relieve the obstruction. The patient made a gradual recovery and was discharged June 19, 1936.

He was readmitted to the same hospital July 24, 1936, complaining of diarrhea, left upper quadrant pain, loss of weight, and swelling of the legs. His condition became rapidly worse and he died July 27, 1936, 29 months after the original cholecystogastrostomy.

Postmortem Examination.—Dr. William Aronson, pathologist to the Morrisania City Hospital, New York City: The body was emaciated. There was no jaundice present. There was an abscess cavity one and one-half inches in diameter at the base of the left lung, surrounded by patchy areas of bronchopneumonia and bronchiectasis. The heart was negative.

Abdomen.—A markedly thickened and contracted gallbladder was attached to the anterior wall of the stomach about one and one-half inches above the pylorus; the aperture was patent, as was that of the gastrojejunostomy stoma. The second portion of the duodenum was markedly narrowed due to extraneous pressure and barely admitted the tip of the middle finger. The head of the pancreas was slightly enlarged but nodular and rock like in consistency. It cut with difficulty. This process involved the head of the pancreas only; the remainder of the gland was normal. The firm mass encroached on the duodenum and infiltrated it, thereby causing constriction. There were no en-

larged lymph nodes in the region of the pylorus, pancreas, or common duct. There were no evidences of metastases, local or distant.

Gross Anatomic Diagnoses.—Carcinoma of the head of the pancreas involving the duodenum. Abscess, bronchopneumonia, and bronchiectasis in the lower lobe of the left lung. Status after cholecystogastrostomy and gastrojejunostomy. Congestive changes of the liver, spleen and kidney.

Microscopic Examination.—Sections through the head of the pancreas, ampulla of Vater, and duodenum adjoining the pancreas showed a diffuse fibrosis with infiltration by many groups of atypical glandular acini which were definitely carcinomatous (Fig. 1). The malignant infiltration extended to just beneath the duodenal mucosa.

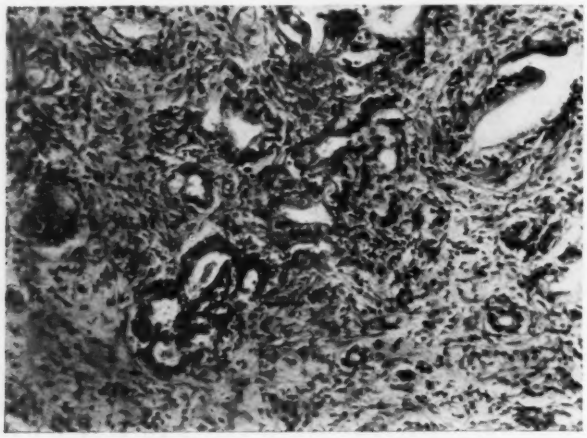

FIG. 1.—Photomicrograph of a section of the head of the pancreas, showing carcinomatous involvement.

Sections of the liver were carefully examined. There was no evidence of any cholangeitis or hepatitis. This fact is particularly stressed, as Sandblom, Bergh and Ivy[7] found only two cases in the literature in which the presence of hepatic infection was definitely excluded at autopsy. In one case a cholecystogastrostomy and in the other a choledochoduodenostomy had been performed.

COMMENT.—The prolonged survival (29 months) following cholecystogastrostomy for carcinoma of the head of the pancreas is unusual. The diagnosis was confirmed by necropsy. The absence of metastases during this length of time is an unusual observation since early metastases are frequent in these cases.[1] The glycosuria associated with disease of the biliary tract in this and similar cases has been previously emphasized.[6] Roentgenologic examination following a barium meal showed air in the biliary system on one occasion, and barium in the common and hepatic ducts at a later examination. However, ascending infection did not occur since there were no microscopic evidences of cholangeitis or hepatitis. The value of the operative procedure of cholecystogastrostomy as a palliative measure in this particular instance is evident.

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A MODIFICATION OF THE TATE MASON METHOD OF CHOLECYSTOGASTROSTOMY OR CHOLECYSTODUODENOSTOMY

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ATTENTION must be called to the fact that often there is no positive differential diagnosis, short of actual exploration, between the so called "silent" common duct stone and a malignancy of the head of the pancreas. The autopsy frequently discloses a benign lesion where a malignant common duct obstruction had been diagnosed. Exploratory celiotomy is, therefore, occasionally indicated even in what apparently seems an inoperable case. Once an exploratory operation has been performed, any subsequent procedure which does not materially increase the immediate risk and which offers an amelioration of the most aggravating of the patient's symptoms is indicated from every humanitarian point of view.

For relief of the symptoms subsequent to obstruction of the common duct by a carcinoma in or at the head of the pancreas, there is no procedure which, in our hands, has been so satisfactory as internal drainage of the gallbladder by the Tate Mason[1] method. We have modified his original procedure by two simple additions in technic.

The first consists of inserting the flaring end of a catheter into the gallbladder and guiding the tip into the duodenum and around toward, or into, the jejunum (Fig. 1). Thus the bile is not poured into the stomach but into the small bowel. It is due to this, we feel, that our patients do not often vomit postoperatively and are not nauseated.

The second modification consists in a simplification of technic, in that it avoids the counter opening as suggested by Doctor Mason. The catheter is fixed into the gallbladder by a simple purse string suture of strong No. 2 catgut. The long ends of this are then threaded on a half curved needle. The

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Fig. 1

Fig. 2

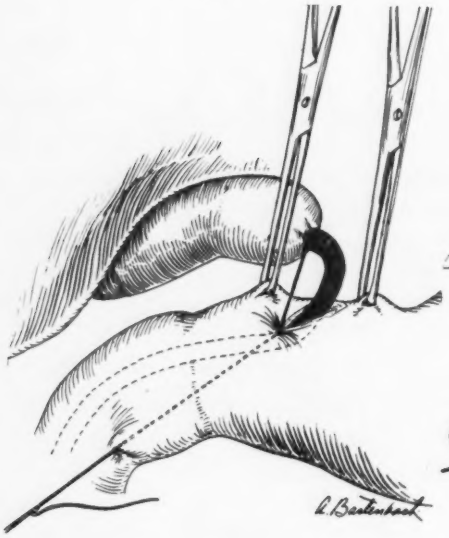

Fig. 3

Fig. 4

FIG. 1.—Catheter has been inserted into gallbladder and held with purse string suture of chromic catgut. Pylorus has been incised and catheter is being inserted into duodenum.

FIG. 2.—Purse string suture of chromic catgut has been fixed to a needle, the needle has been inserted through the incision and is seen being passed out through duodenum.

FIG. 3.—Suture is being drawn taut, thus inserting gallbladder well within lumen of stomach.

FIG. 4.—Gallbladder and pylorus approximated with interrupted through-and-through sutures in such a way that only serosal apposition is obtained. The traction suture is being cut close to the bowel and the cut end will be allowed to withdraw into the lumen of the bowel.

needle is inserted through the gastrostomy into the duodenum and passing through the bowel from within out (Fig. 2) is caught and the suture grasped. Pulling on this suture pulls the gallbladder after it (Fig. 3), introducing the

fundus of the gallbladder well within the lumen of the stomach or duodenum, as the case may be. A series of interrupted sutures holds the gallbladder and stomach or duodenum together (Fig. 4), care being taken of course to invert the mucosa so that there is a serosa to serosa approximation.

The entire procedure takes but a few minutes. The postoperative convalescence is remarkably smooth. The patient usually passes the catheter some time from the second week to the second month after operation. (It is necessary to warn the patient of this. We once neglected to do so and the poor patient was nearly scared into a psychosis because he thought he was passing a snake.)

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RUPTURE OF THE LIVER WITHOUT TEAR OF THE CAPSULE

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Case Report.—R. E., male, age 14, was knocked from his bicycle by a motor car November 8, 1934, and thrown for a distance of from 12 to 14 feet on to a bank. He was able to walk into the hospital and, although objecting to remaining, was, however, put to bed after having received treatment for some minor cuts on the face and scalp. During the night he complained of pain in his right shoulder. His pulse ranged between 130 and 140, and he showed considerable shock. During the next few days his temperature gradually rose to 104° F.; W.B.C. 18,000. During all this time he complained bitterly of pain in his shoulder. He was transfused, but this did not alter his condition. On November 14, he showed some slight jaundice, his temperature continuing for awhile at about 102° F. The patient was extremely ill. Blood cultures were negative. On November 24, the pain in his right shoulder became much more severe. Temperature was 105° F., pulse 130. He was again transfused, with very little change in his condition. He became progressively worse until on December 2, his temperature was 106° F., respiration 40, pulse 120. The rapid breathing was not the type accompanying pneumonia.

Examination of the chest apparently indicated pathology in the right lower lobe. The percussion note was very dull. No breath sounds could be heard in this area and there was skodaic resonance above it. The dulness of the chest seemed to be continuous with that of the liver. The veins of the right abdomen were enlarged. On palpation no rigidity existed, there was no tenderness. The abdomen was soft and no demonstrable fluid was present. The liver margin was palpable one finger's breadth below the costal margin. He had tenderness over the liver and there seemed to be a slight bulging at the right costal margin. Lying on his left side caused pain on his right side. Roentgenologic examination showed the diaphragm very much higher than normal on the right side, being located at the level of the fourth rib in front (Fig. 1).

The history and the physical findings made it appear probable that he had had a central tear in his liver with subsequent infection which was now producing a liver abscess. Operation was undertaken December 3.

The abdomen was opened through a Kocher incision. The liver was found to be

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two fingers' breadth below the costal margin. It was enlarged, the surface smooth. The hand, passed up over the front of the liver, encountered some recent adhesions between the liver and the diaphragm. These were easily separated, leaving a slight roughness on the surface of the liver. Palpation of the liver between one's hands did not demonstrate any area of fluctuation, its general resistance seemed normal, and there was no area where one could be sure that an abscess existed in its substance. Its color was normal throughout and gave no indication of any underlying pathology, except for the small area that had been the site of the adhesions. By retracting the ribs one obtained a better view of the anterosuperior surface of the liver, and the site of the small roughened area, into which a needle attached to a 50 cc. syringe was introduced. After passing

FIG. 1—Roentgenogram showing elevation of diaphragm before operation.

FIG. 2.—Roentgenogram showing the diaphragm closer to normal position following operation. The drainage tube can be seen in situ.

through two inches of liver substance of a normal resistance, the needle apparently entered a cavity, from which 250 cc. of pus were aspirated. It was a dark, grumous, reddish-brown material. There was no leakage about the needle, and it was left in situ. A coffer-dam was placed in the gutter to the right of the liver. The parietal peritoneum just below the level of the abdominal wound was sutured to the surface of the liver from the midline to the posterior axillary line. The space behind this was drained by a stab wound in the flank, for the purpose of anticipating infection in that situation. An incision was made above the abdominal wound opposite to the point of aspiration of the liver, and pieces of the eighth and ninth ribs were resected together with parts of the costal cartilages. A square opening was then cut into the peritoneal cavity, which was situated exactly opposite the entrance of the needle into the liver. A sterile rectal tube was then passed through the quadrilateral opening, the needle removed, and sinus forceps carrying the rectal tube were introduced into the abscess cavity. The tube fitted closely and there was no leakage around it. This brought the surface of the liver with the protruding tube firmly against the opening in the abdominal wall. The tube was then sutured to the abdominal wall, and the abdominal incision closed (Fig. 2).

The postoperative condition was good, and during the first 24 hours his tempera-

ture did not go over 100° F. For six days there was a slight amount of discharge through the tube, which was removed on the tenth day; the wound closed promptly and has remained so. Within six weeks he was able to resume his normal activities, and now, 11 months from the time of his accident, he is apparently normal.

The material evacuated from the liver abscess showed pus cells present. An occasional gram-positive encapsulated Diplococcus. T. B. smear negative. The organism isolated in broth was agglutinated by pneumococcus serum Type I. This organism did not ferment inulin after 24 hours nor was it very actively bile soluble, which would place it in the Streptococcus group. However, as capsules were present and the organism was agglutinated by pneumococcus antiserum Type I and not by Type II or Type III, we believe it to be pneumococcus Type I.

DISCUSSION.—This boy showed the outstanding points that were noted in a previous article[1] on this subject. This makes the third case when added to the other two and is sufficiently like them to be added. The literature in connection with this type of case was outlined in the previous communication. It is interesting to note that this patient complained of the same type of distress on the right side with pain in the right shoulder, inability to lie on the left side, dilatation of the superficial abdominal veins, dulness of the right base of the lung, elevation of the diaphragm on the right side, and slight enlargement of the liver as evidenced by its inferior margin being one or two fingers' breadth below the costal margin. The fact that this boy had a hemorrhage deep in his liver followed by abscess formation did not in this particular case produce any demonstrable quantity of bile from the sinus. If there had been bile radicals torn, they had had sufficient time to become absolutely sealed off by the time of the operation, and the prompt closure of the sinus without the discharge of any bile makes it appear that perhaps the element of bile in the cavity does not require any special treatment.

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CALCIFIED CYST OF THE SPLEEN

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Case Report.—T. G., a white female, age 18, Canadian, entered the Detroit Receiving Hospital May 30, 1934, complaining of nausea, vomiting and pain in the right lower quadrant of the abdomen. For the preceding two months, she had had recurrent pains in the same region, with no other associated symptoms. Five days prior to admission she had an exacerbation of the same symptoms, associated with anorexia, chills, nausea and vomiting. There were no urinary complaints. Nearly three months previously she had fallen, injuring the right hip, following which she had abdominal pain lasting about

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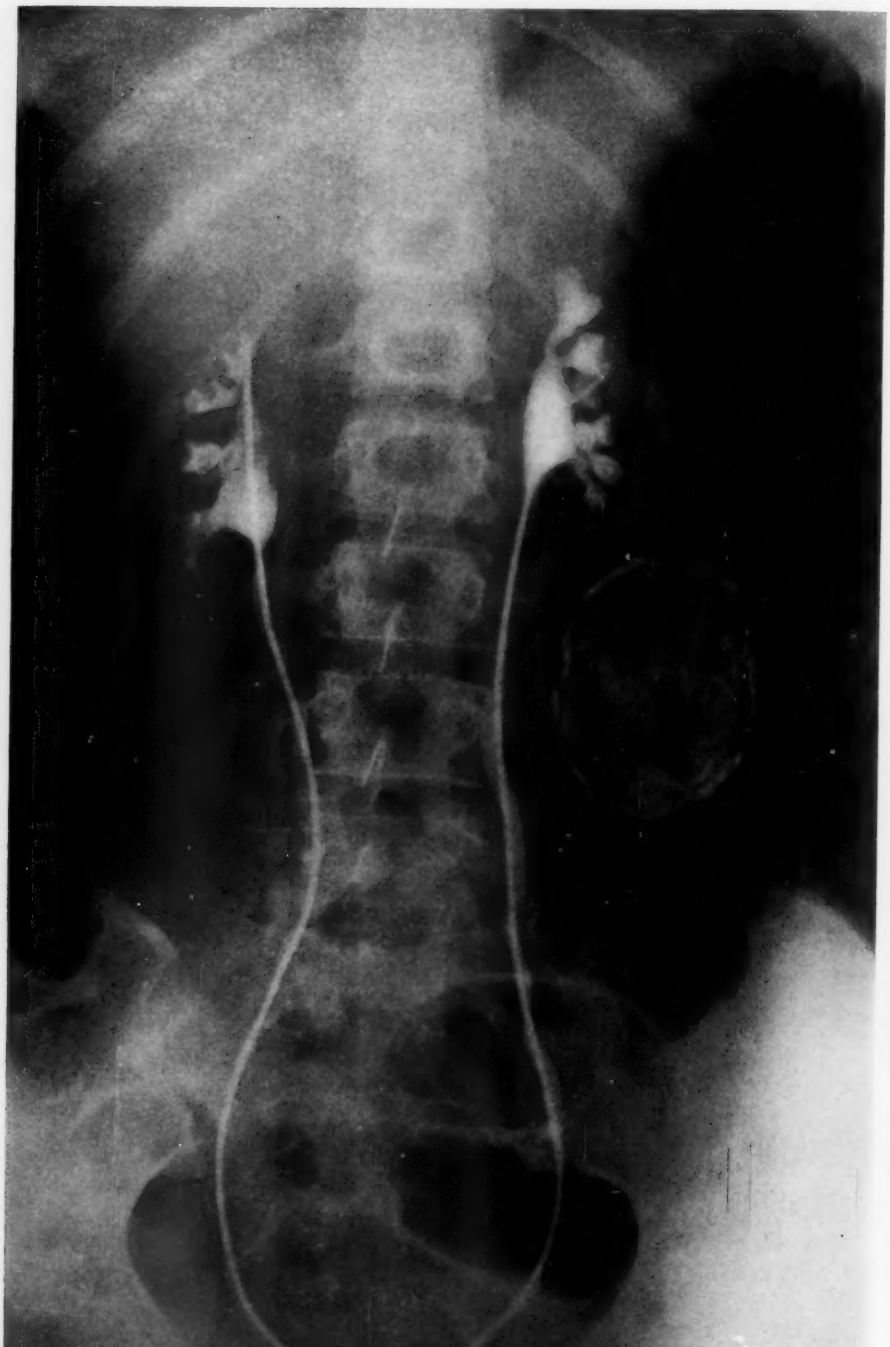

FIG. 1.—Pyelograms showing normal kidneys. The large, irregularly ovoid shadow in the upper left abdomen proved to be a calcified cyst of the spleen.

24 hours. She had had scarlet fever. Her tonsils had been removed. Her menses were regular.

Physical Examination.—On admission, most of findings pointed to the appendiceal region. The temperature, pulse and respiration were normal. These findings continued until June 4, 1934, when physical examination revealed a large movable mass in the upper left quadrant. In consequence of having noted a similar condition on physical examination previously,[1] a clinical diagnosis of cyst of the spleen was made and roentgenologic studies were made.

Roentgenologic Examination.—Dr. J. D. Kenning: The lower lumbar spine, pelvis and hip bones were apparently normal. Pyelograms, prepared by Dr. W. K. Rexford, showed both ureters and kidneys to be within normal limits. A large oval shaped shadow was present in the upper left quadrant of the abdomen (Fig. 1). Fluoroscopy revealed no association between this shadow and the colon.

Laboratory Data.—Analysis of the blood showed: Hemoglobin 13.8 Gm. per 100 cc.; red cells 3,860,000; white cells 7,300. The Kline test was negative. The urine was normal. In addition, the usual throat, nasal, microscopic, chemical and blood cultures were all noninformative.

Operation.—A splenectomy and appendicectomy were performed June 12, 1934, through an upper left rectus incision. A freely movable spleen was delivered with ease, pedicle clamped and the spleen was removed. The pedicle was tied off with multiple ligatures. A long, markedly dilated appendix, containing several very large fecal concretions, was then removed. The gallbladder, liver, pelvic organs and the kidneys were apparently normal as to the size, shape and position. The abdomen was closed without drainage.

Pathologic Report.—By Dr. O. A. Brines: "The specimens consist of the appendix and spleen. The spleen weighs 230 Gm. and measures 16 cm. in length and 8.5 cm. in diameter. One-half of the spleen is approximately twice the normal size and is occupied by a cyst 6 cm. in diameter and 3.5 cm. in thickness. The wall is calcified and measures approximately 2 Mm. in thickness. The cavity is filled with white, thin fluid containing cholesterol crystals. Microscopically, the sections of the spleen contain within them a portion of a cyst wall, which is composed of dense fibrous tissue, within which there is a large amount of calcium deposition. The surrounding splenic tissue is somewhat loose in structure and the sinusoids are uniformly dilated. The pathologic diagnosis is calcified cyst of the spleen."

The girl made an uneventful recovery and was discharged from the hospital 12 days after operation. She has been seen at frequent intervals since and appears to be in the best of health.

Comment.—Effort has been made to determine the origin of the calcified cyst of the spleen. The young woman had no menstrual disorders and with the exception of scarlet fever, no serious previous sicknesses. She stated she had fallen on her right hip three months previous to operation and at that time had abdominal pain lasting 24 hours. The pain was generalized and not confined to the splenic area. It seems unlikely that it was of congenital origin. She gave no history of echinococcus infection and no evidence of this disease was found in the removed spleen. While she had no signs of tuberculosis elsewhere, the possibility that the cyst was of tuberculous origin was considered during the operation. This opinion was not substantiated by its subsequent pathologic examination. Cysts and deposits of calcium do occur in the spleen, but the origin of this particular calcified cyst remains undetermined.

Discussion.—The nature and methods of deposits of calcium in the spleen

is still unknown. However, it is rarely seen in diseases, such as gout, or where there is a generalized deposition of calcium throughout the rest of the body. Possibly they result from miliary tuberculous foci, or infection by the echinococcus, which have become inactive and calcified. That they may be a late result of trauma must be considered, because a history of injury is occasionally obtained.

Four types of calcium deposit in the spleen are encountered: Small deposits of calcium; large, solid calcified tumors; atheromatous splenic arteries and cysts having calcified walls.

(1) *Small Calcium Deposits.*—These are thought to be the result of infection followed by calcification during the process of healing or are phleboliths. In spite of the few reports of splenic opacities from the roentgenologic standpoint, most radiologists must have observed them. Spillan and Terrier, according to Fowler,[2] found calcified deposits and areas in the spleen. Mitchell,[3] in reporting a case of multiple splenic calculi, states he had seen several others intra vitam and two postmortem. In his reported case, the calculi were just beneath the capsule of the spleen. Chemical analysis showed them to consist of 67.7 per cent calcium carbonate. Pool and Stillman[4] report one case diagnosed roentgenologically, but which was not proven pathologically. Vallebona[5] reports two cases of calcification of the spleen, the first showing several lentil-sized rounded shadows, suggestive of tuberculosis or calcified parasites, and the second showing larger, irregular shadows. Scott and Cotton-Cornwall[6] report a case, in which there was a calcified plaque in the spleen, along with calcified areas in the pleural cavity. They feel that calcification occurs more commonly in tuberculosis. Although they were able to find but few cases reported in the literature, they believed that the introduction of roentgenologic examinations have made observation of splenic calcification fairly common.

(2) *Large Calcified Tumors.*—Mount, Mount and Hunter[7] report a large calcified tumor, 7.5 cm. in diameter, and state they found no reference in the literature to such an extensive deposition of calcium salts in the spleen. This was diagnosed roentgenologically. Pathologic report of the removed spleen showed it to be a practically solid calcified tumor. They believe it to have been traumatic in origin.

(3) *Shadows Seen in Roentgenograms Due to Atheromatous Arteries.*—In a review of the literature, several cases are noted in which the roentgenologic shadow was found to be due to abnormalities of the splenic artery. Baumann[8] describes a case of an apple-sized cyst of the spleen with calcification of the wall, occurring in a patient, who at the same time suffered from a carcinoma of the bronchus. The splenic shadow was an incidental finding. At postmortem examination, it was found that the lesion of the spleen was an aneurysm of the splenic artery with calcification of the walls. Israelski[9] describes a case which showed a rounded formation following the ascending ramification of the gastric artery. At the autopsy, a calcified, tortuous splenic artery was found. According to Pool and Stillman,[4] Beaussenat (1892) and

Binder (1913) found atheromatous aneurysmal splenic arteries at autopsy, which might have cast shadows in a roentgenogram of the splenic region.

(4) *Calcified Cysts of the Spleen.*—From the literature, it seems that cysts with calcified walls are uncommon. Fowler[2] cites a few cases of calcified cysts of the spleen. He notes that Guio and Venardi reported a calcified cyst of the spleen, the size of a small nut, containing albuminous fluid, which effervesced in hydrochloric acid. He refers, also, to a case report by Mattei (1885) in which the wall was hard, cartilaginous in some places and calcified in others. The larger cysts were the size of an orange and the walls were calcified. Smaller cysts grouped around the larger, varied in size from that of a hemp seed to that of a large nut. Foldes[10] reports a laborer, age 49, who for 22 years had had repeated chills. The patient had grown weaker for three years, and three months before examination had lost considerable weight. Roentgenograms showed a homogeneous spherical shadow in the splenic region, which moved with respiration, 8 cm. wide and 6 cm. high, with a capsule 2 to 3 cm. thick. At operation, a calcified cyst of the spleen was found, the microscopic report being that it was a simple fibrotic cyst. Gatersleben[11] reports a case of cyst of the spleen, with calcification of the wall, in which the diagnosis was made roentgenologically. At the operation, a calcified cyst, the size of two fists, was found in the upper pole of the spleen. Following splenectomy, there was complete healing. Scotson[12] (1933) reports a case, in which a large calcified mass in the upper part of the abdomen was seen in the roentgenogram. After splenectomy, this proved to be a large solitary calcified cyst of the spleen.

It is possible that an untreated cyst might go on to complete solid calcification. This may explain the extreme rarity of solid calcified tumors, of the type described by Mount, Mount and Hunter.

The treatment of small deposits requires very little discussion. Where the deposits are large and a tumor or calcified cyst of considerable size is present, operative removal may be indicated.

SUMMARY

(1) A solitary calcified cyst of the spleen is described, and a brief summary of other types of calcium deposits in the spleen is given.

(2) The patient was a young woman, who had no menstrual disorders and no important previous infections.

(3) There was a previous history of injury to the right hip, followed by abdominal pain, lasting 24 hours.

(4) The presence of a fairly movable, slightly tender tumor in the upper left quadrant of the abdomen indicated a clinical diagnosis of splenic tumor. Roentgenologic examination, splenectomy and pathologic examination determined the final diagnosis of a calcified cyst of the spleen.

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CYST OF THE UTERUS

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Case Report.—A woman, age 38, entered St. Luke's Hospital complaining of severe pain in the lower abdomen. She had been perfectly well until the day before admission when she noticed some lower abdominal distress which had disappeared by evening. Early on the morning of the day of admission she awoke with pain that continued despite an injection of morphine. She vomited once. Her last menses had occurred three weeks previously. Menstruation had always been normal. She had had two children and one miscarriage, the latter was treated by curettage. The history was otherwise unimportant.

Abdominal examination demonstrated the presence of a tender mass rising above the symphysis in the midline. Vaginally the tumor was felt as a cystic mass filling the pelvis. The cervix could not be reached by the finger. The general condition of the patient was excellent. Temperature 99.4° F. W.B.C. 18,000 with 80 per cent polymorphonuclear leukocytes.

Operation.—The abdomen was opened through a low midline incision. The uterus and appendages, perfectly normal in appearance, presenting at the lower angle of the wound, were displaced upward by a retroperitoneal cystic tumor filling the pelvis. Upon splitting the peritoneum over the cyst it shelled out easily except for its attachment by a stalk about the size of the distal phalanx of the finger to the upper part of the cervix in the midline. It contained 28 ounces of bloody fluid with numerous clots. After the stalk had been cut through, a small opening was found which admitted a probe into the cervical canal. That this opening could have communicated freely with the cyst seems unlikely as there had been no note of vaginal bleeding although the acute symptoms had apparently been due to hemorrhage into the cyst.

Pathologic Examination.—Dr. L. C. Knox: "The wall is 1 cm. in thickness throughout the greater part, but on one side it is increased by fibrous tissue to about 2.5 cm. Within the thick part of the wall there are several smooth lined cysts which contain a glairy material. Section of various portions of the lining of the cyst show it is covered

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with a layer of columnar cells with mucus producing epithelium which tends to have a clear cytoplasm and rather small basal nuclei. It is fairly well preserved but forms only a single layer. This covers a mass of muscle and fibrous tissue in which the muscle nuclei are rather large and plump but the bundles are separated by broad hyaline bands. The vessels also have very thick hyaline walls. There are no characteristic glands with stroma embedded within the muscle and therefore the tissue does not suggest an adenomyoma."

Cysts of the uterus are not ordinarily described as an entity although Meyer[1] devotes a section to them in the Veit-Stoeckel Handbuch der Gynäkologie. The more recent literature contains reports of a number of cases of large uterine cysts, in the main from German sources. Of 22 cases collected,

FIG. 1.—Photmicrograph of cyst wall.

including the present report, the cyst arose from the fundus and body in ten, usually to one side of the midline; from the side of the uterus in nine; from the cervix in two, one from the midline posteriorly and one from the side wall; and from the lower uterine segment and cervix posteriorly in one instance. The fluid contained in the cyst was variously described as clear, serous, mucoid and in eight instances bloody.

Meyer states that the lining of uterine cysts may be a single layer of epithelium or endometrial mucosa. One or more layers of cylindrical or cuboidal epithelium resting directly on a fibromuscular wall seems to be the more common finding in this series. Small cysts are frequently found in the wall. In two instances carcinoma had developed.

It may be adding an element of confusion to report these cases as cysts of the uterus rather than as cystadenomyoma. Cullen[2] states that whenever subperitoneal or intraligamentary adenomyoma reach any size they become

cystic. A number of the reporters considered their cases to be of endometrial origin and some described endometrial penetration of the wall of the uterus adjacent to the origin of the tumor. Meyer thinks that displacements of the müllerian duct epithelium into the muscle during development are to be thought of first as the basis of uterine cysts. Remnants of Gärtner's duct are commonly assigned as the origin of those cysts arising in the side wall of the uterus.

Tumor as manifested by enlargement of the abdomen and pain are the most usual symptoms. The condition is most frequently diagnosed as ovarian cyst. The age of the patients has varied between 20 and 50, the majority being in the neighborhood of 40. Of 20 in whom the parity is mentioned nine had not borne children.

SUMMARY.—A case of a large cyst arising from the uterus and lined with cylindrical epithelium on a fibromuscular wall is reported and discussed in connection with 21 other cases gathered from the literature.

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A METHOD OF DEALING WITH PROFUSELY DRAINING ABDOMINAL WOUNDS

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In the treatment of abdominal wounds having abundant discharge as well as being chronically infected, two major problems arise. The first is that of the disposal of excessive secretions and excretions which seem to evade the bounds of dressings, even though the latter be frequently changed. In addition to the discomfort of the patient in lying in a constantly unclean bed, the application of several dressings daily is a needlessly time consuming task and unnecessary expense. The second problem to be faced is that of applying the fundamental surgical principle of keeping a wound clean in order that healing may progress.

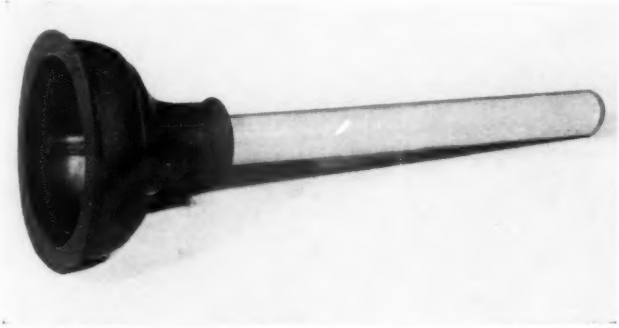

Fig. 1.—"The plumber's friend." The handle is removed and the rubber part into which it fits is cut off flush with the top of the cup.

In an effort to find the solution of these two problems in the routine care of such patients, the simple suction apparatus presented herewith has been devised.

The primary requisite is the availability of continuous suction. The materials required are sufficient rubber tubing, glass connectors, Montgomery adhesive straps, a de Pezzer catheter, rubber band, vaseline, and a "Daisy" suction cup No. 400. The latter is an adaptation of a sucker used to clean

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sink drains, better known as "the plumber's friend" (Fig. 1). It can be obtained at any department store.

From the rubber cup of the "plumber's friend," that portion is cut into which the handle fits. A hole 1 cm. in diameter is cut in the top for an air inlet. About 1 cm. above the rim of the cup another hole is made of sufficient size so that a No. 30 or 32F. de Pezzer catheter will fit snugly. The rubber cup used is rigid enough to retain its shape, and yet plastic enough to conform to the contours of the patient's body. The brim of the cup is sufficiently wide to prevent its cutting into the skin of the abdomen with the pressure exerted. The air inlet prevents the development of a partial vacuum which might severely traumatize the tissue. By the use of a de Pezzer catheter and the arrangement of it so that one hole in its tip will be next to the wound and the other toward the top of the cup, a free passage way is assured in the event that tissue should be sucked into the lower opening. The arrangement of this portion of the apparatus is shown in cross-section in Fig. 2.

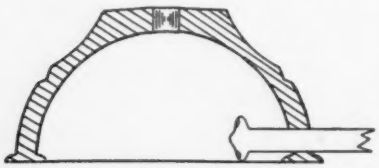

FIG. 2.—Cross-section of suction cup with the de Pezzer catheter in place.

In setting up the apparatus in its simplest use, the skin of the abdomen is relatively thickly covered with vaseline from the margins of the wound outward to a distance comparable to the diameter of the cup. This not only makes a watertight contact of the cup with the skin, but serves to protect the skin from irritating secretions or excretions. The cup is placed over the wound and secured in place by two Montgomery straps joined by a rubber band. A great amount of tension of the rubber band is not necessary, and indeed is undesirable, since too much pressure upon the skin may produce edema of the area within the cup. The catheter is connected to the suction and the apparatus is ready for use. Figs. 3 and 4 illustrate this set-up in use. The patient shown had far advanced urinary tract tuberculosis with stricture of the urethra. The cystostomy wound gradually broke down around the drainage tube so

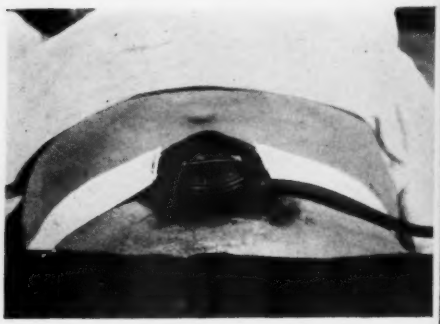

FIG. 3.—Front view of the simplest arrangement of the suction cup showing the Montgomery adhesive straps and rubber band in place.

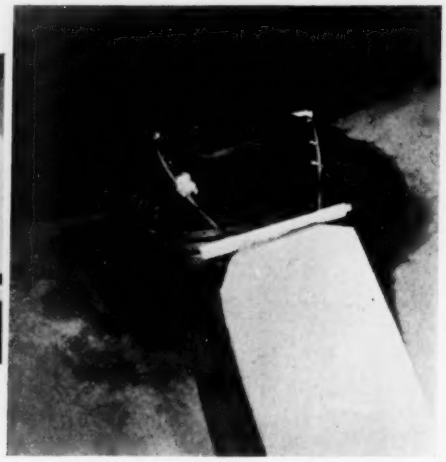

FIG. 4.—Same as Fig. 3, side view.

that a water-tight wound could no longer be maintained, and urine leaked from around the tube to such an extent that the patient and his bed were almost constantly wet. Since the application of the suction cup the reverse has been the case, and, whereas three or four changes of bedclothing daily were previously necessary, now the routine morning nursing care suffices for the remainder of the day.

A secondary appliance for this apparatus is the introduction of an irrigating mechanism. This can be effected by making another small hole in the top of the suction cup, through which a soft rubber catheter is introduced leading through the cystostomy wound into the bladder. To this catheter is connected

FIG. 5.—Suction cup with one method of irrigation shown. The catheter, entering the top of the cup and connected with the reservoir, extends into the bladder. The larger de Pezzer catheter seen in the foreground connects to suction.

a reservoir of irrigating solution. Fig. 5 shows this outfit in operation in a patient with a necrotic and secondarily infected cystostomy wound. At stated intervals about 100 cc. of solution are allowed to run into the bladder and well up through the cystostomy wound to be sucked off from the confines of the cup.

A further arrangement for irrigation of a chronically infected cystostomy wound is demonstrated in Fig. 6 with the addition of the bladder irrigating apparatus adapted from the Connell apparatus. The indwelling urethral catheter serves for the introduction of the irrigating solution, about 150 cc. at intervals, which passes upward through the wound into the cup from which it is sucked away. In the meantime, between irrigations, urinary drainage is effected in the usual manner through the urethral catheter into a container beneath the bed.

Another adaptation of this method is suggested in the care of fecal fistulae. A reservoir of irrigating solution may be incorporated into the simplest suction mechanism (Figs. 3 and 4) by a glass Y-tube. While the suction is momentarily pinched off, about 50 cc. of solution are allowed to run into the suction cup loosening the feces and lavaging the fistulous opening. The tube from the reservoir is then closed and the suction opened to remove the solution and suspended fecal material.

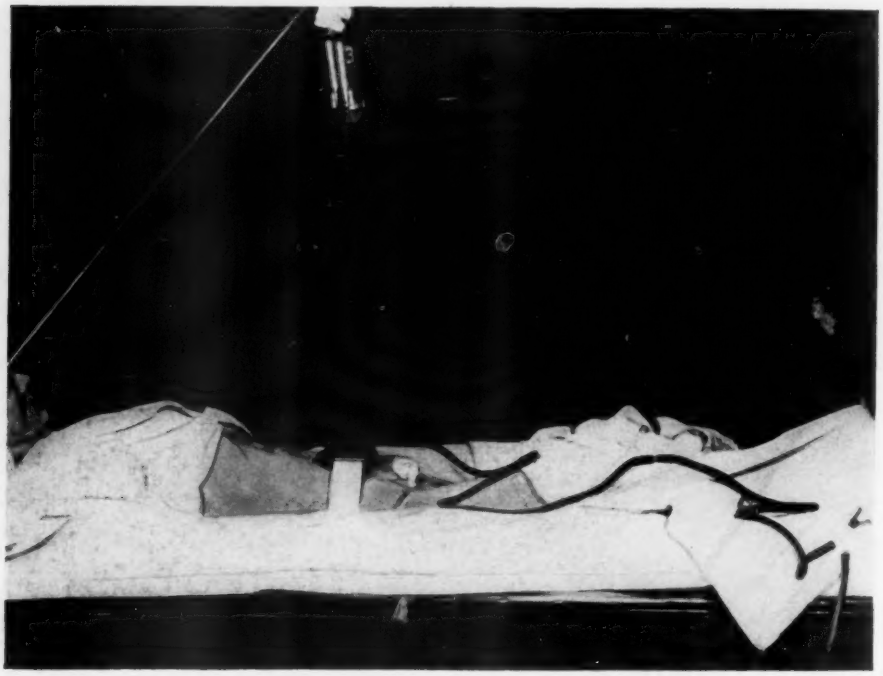

FIG. 6.—Suction cup showing urethral catheter in place connected to the bladder irrigating apparatus adapted from the Connell arrangement.

The use of the suction apparatus and its adaptations described above has been but recently instituted in a few cases, but its effectiveness in disposing of excessive secretions from cystostomy wounds, and in permitting a method of irrigation, has in this short time proved so successful as to be worthy of attention. Its simplicity of construction is also to be recommended.

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